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Engineering News-Record

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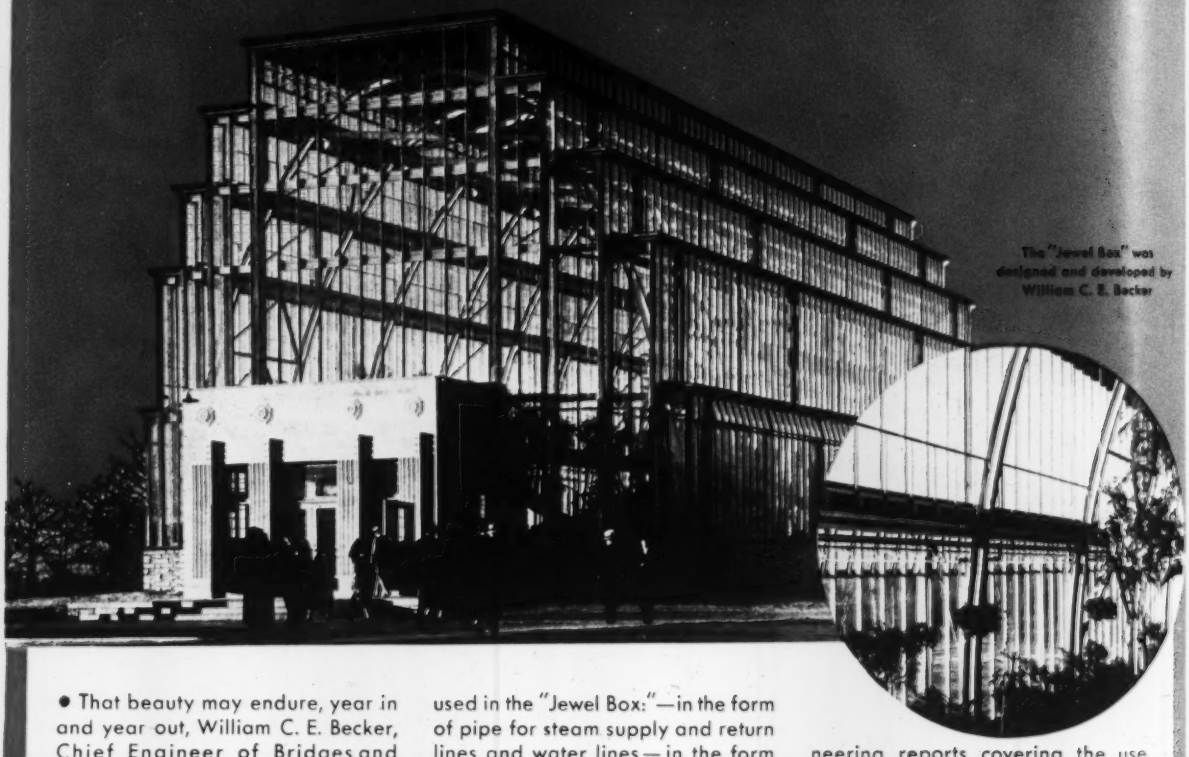

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As Much as We Are Willing to Pay for

THE newspapers report that six governors have requested an opportunity to show the President why the present intention to curtail WPA expenditures should be reconsidered. They believe that the Federal Government should continue to provide work relief to all the needy employables and they protest against passing the burden of unemployment relief to the states and local units.

All this recalls a recently reported comment that "the country can have as much unemployment as it is willing to pay for."

That comment deserves to be pondered. In it may be found one key to the riddle of persistent unemployment despite increasing business activity and an actual shortage of workers in some fields. When "relief" becomes a regular, large-scale public function it tends to breed a new attitude toward the acceptance of public support.

Once it was a matter of personal pride not to be "on the town." It was a matter of community pride not to have a lot of people "on the town." Self-support was the ideal of the individual; a self-supporting population was the ideal of the community. Self-support was the vogue.

TODAY that attitude has changed appreciably. The individual has heard so much about the community's duty to him that he finds it easy to forget his duty to the community. In many cases the acceptance of public support no longer is a tragic last resort but rather a natural right. One debates whether to "take a job" or "stay on relief." Governments swell their budgets in the name of "relief"; public officials display their relief budgets as badges of honor rather than as open sores. They are ready to starve the productive public activities that make normal employment for their hard-working citizens in order to provide for "relief." Dependence may yet become the vogue.

Naturally this trend will not be corrected by the professional relief workers. Trained in the tradition and technique of spending, they know and care little about the labor of earning. Heretofore limited to the extraction of funds from discriminating private sources or from public sources under a less free-handed psychology, they now are enjoying a field day. Like Alexander Hamilton, they "smote the rock of the national resources, and abundant streams of revenue gushed forth." And having tasted them, they are not likely to do very much about shutting them off.

Obviously it is not the popular part to say such things. And in saying them, this writer neither advocates nor condones an inhumane and ruthless attitude toward the truly deserving unfortunates who, through no fault of their own, are unable to find jobs at this time. Judicious and practical help for them must be always the concern of a civilized society. As agents of such a society the nation, the state and the local community each has its part to play.

BUT it is about time to face the fact that both direct and work relief on so vast a scale as has prevailed are emergency measures. If they be established as a permanent business of the state we may well dry up the necessary sources of help for those who should have it. It is not fair to them or to the rest of the community to provide public support for those who won't work as well as for those who can't work; to make it available on equal terms for those who deliberately quit their jobs and those who can't find them; to establish a public policy that all who may be willing to accept a minimum standard of living may have it at the public expense.

Some two years ago this writer said that the social crisis of the depression would come when someone in authority displayed the abdominal fortitude to declare the emergency ended and to wind up "this business of relief." The time for that is approaching, but the job will not be done unless those in authority seek counsel elsewhere than among the relief professionals.

It is regrettable but all too true that the country can have and will have as much unemplyment as it is willing to pay for.

Willard Chevalier

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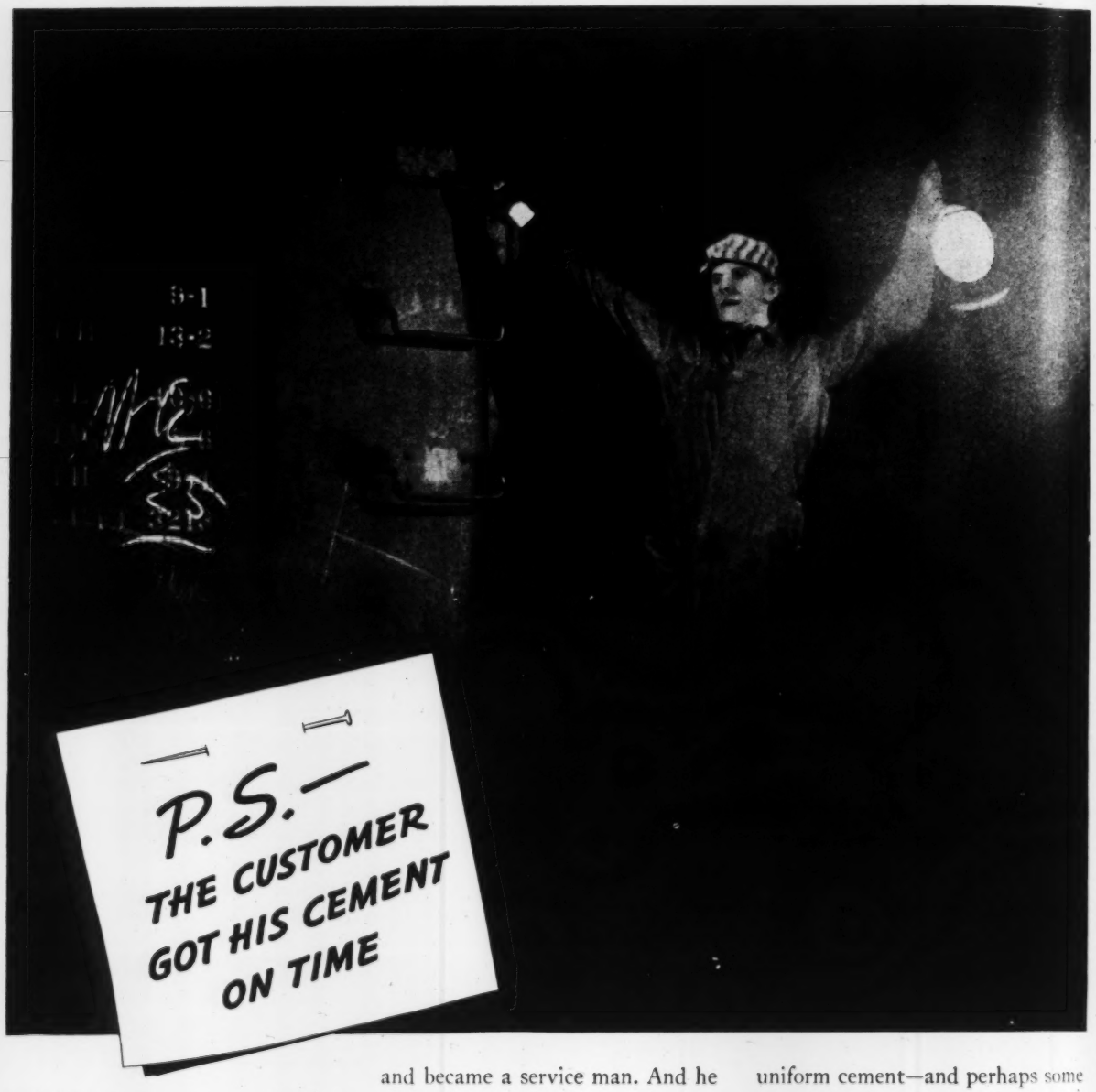
■

Basic Thinking on Flood Control— Most People now think of Arthur Morgan as head of the TVA and concerned chiefly with power matters. They overlook the fact that long before the TVA was thought of he planned and carried to successful completion the nation's first coordinated flood-control project—that in the Miami Valley in Ohio. He still is a close student of flood control. At the request of the editors he has set down his views as to the fundamentals to be considered in national planning for flood control. Dr. Morgan's views will be published next week.



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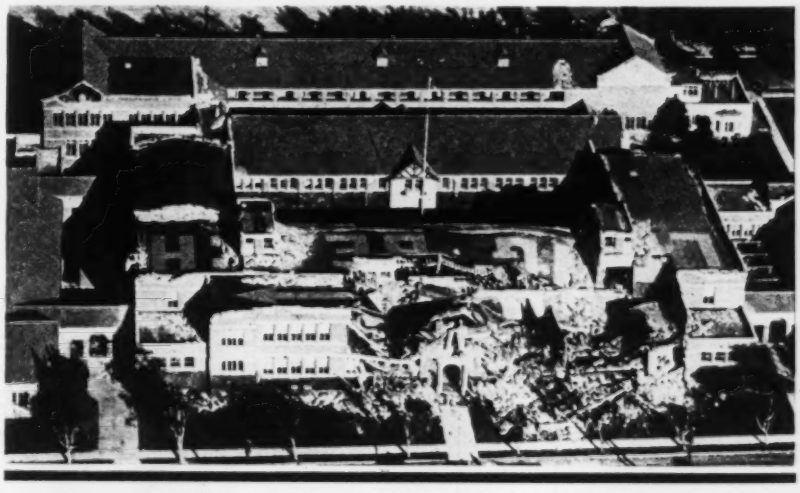


SCHOOL BUILDING AFTER AN EARTHQUAKE.

Safeguarding Schools Against Earthquakes

Aroused by effects of the 1933 earthquake in Southern California, public support made possible sweeping changes in school buildings—Damaged schools rebuilt and improved designs adopted

By A. S. Nibecker, Jr.
Business Manager and Architect, Los Angeles Board of Education

EDITOR'S INTRODUCTION

School children were dismissed at the usual hour in schools of the Los Angeles metropolitan area on the afternoon of March 10, 1933: two hours later the Long Beach earthquake occurred. Had the pupils been in their classrooms when the shock came hundreds, perhaps thousands, would have been killed or maimed as walls fell outward, floors collapsed and towers toppled into main entrances. Structures other than schools were damaged too, but somehow the fatally weak spot in architectural and construction practice was in public school buildings. Rehabilitation and rebuilding of Los Angeles schools has cost a total of about $40,000,000.

The amount of experience with seismic-resistant design accumulated since 1933 is indicated by the fact that the California division of architecture in this period has approved $84,000,000 worth of structural work on schools and public buildings. This total sum covers 1,991 building projects, of which about 1,400 are in Southern California. To make available the knowledge that has been accumulated in carrying out this large amount of seismic-resistant construction *Engineering News-Record* invited three men holding key positions in the school rehabilitation program in California to record the essentials of problems that have been faced and how they were solved. Two of the articles are published in this issue; the third will appear next week and will be devoted to the design of new buildings in contrast to the repair of damaged buildings covered in this issue.

The three articles taken together give a well-rounded picture that is without precedent in the field of structural engineering.

RAPID DEVELOPMENTS subsequent to the Long Beach earthquake of March 10, 1933, brought about entirely new conditions under which the safety standards of school buildings in the city of Los Angeles are judged and maintained. The change was accomplished by an extensive program which it was possible to start only when public sentiment had been aroused; with popular support work of wide scope and unprecedented character was carried on with the greatest dispatch. The severity and harshness of the alarm sounded by the Long Beach earthquake was emphasized by reports of the coroner's jury, the Grand Jury and other inquisitorial bodies; all of these influences impressed upon the public its duty toward the Los Angeles Board of Education. The attitude of the board itself was not so much changed by the incident of the earthquake but the board's good intentions could be translated into action when revelations of the 1933 disaster developed widespread popular support. This support and a willingness to provide funds probably could have been brought about only by some such upheaval as the Long Beach disaster which could adequately emphasize the issues at stake.

The spirit which carried the bond issue for safeguarding schools indicated that a thoroughly aroused public may be depended upon to go through to a successful conclusion with a school safety problem. There is ample evidence, however, that public opinion is fickle; even now, with Long Beach evidence less than 4 years old, there is heard from non-technical sources the criticism that some of our earthquake ordinances and regulations are too stringent. Luckily the rehabilitation program and the higher standards for

new construction were set definitely while the lesson was fresh in mind. Thus there is prospect that the effect will be lasting. The resultant ordinances and regulations probably are the most valuable and tangible results of the Long Beach earthquake.

Apathetic public opinion

Prior to 1933 the school safety problem rarely was considered by the public except in the matter of fire hazard. It was well known to geologists and to some engineers that the southern part of the Pacific Coast is actively engaged in the modification of its physical geography and that no spot in such a region is immune to earthquake shocks. Technical and professional organizations from time to time drew attention to the lectures and teachings of the Seismological Society but popular interest never went beyond the point of considering the subject an instructive amusement.

Earthquakes of major intensity have occurred in California about once in each generation but only infrequently have they affected centers of population and so far as the general public was concerned the shocks were received only through newspaper headlines. In this condition of apathy we lived on, oblivious to the old Mexican history of the locality and heedless (at least so far as action was concerned) of the warnings of San Francisco, San Jacinto, Inglewood and Santa Barbara disasters.

The Tokyo earthquake of 1923 focused interest on seismology and on structures resistant to lateral forces but this interest soon waned except in the case of a few technically minded individuals. The interest of this small group was exceedingly fortunate because it started and carried on certain lines of structural study and research which later was to provide the groundwork for a much more advanced structural design. This small group of technical men was active after the Santa Barbara earthquake of 1925 and through their influence a number of committees were appointed by professional and municipal organizations to study and report on various phases of the Santa Barbara shock. The Los Angeles Board of Education took an interest in these reports and caused a fairly complete study and summary of them to be made. The time was not yet ripe, however, and practical results were not obtained for the following reasons:

When this study was made the Board of Education was well launched into a building program involving some 300 school sites. To meet the requirements of a rapidly growing community the building program had been extended until available funds were stretched to the limit. Thus there was discouragement in the reports of our best engineers and architects as to the cost of providing seismic-resistant features in the proposed school buildings. Resistance to "earthquakes of average intensity" would add 12 to 16 per cent to the cost, they estimated. Even these figures (much higher than present-day estimates would be) represented the opinions of a small minority of the Board's technical advisers, and public opinion in nowise was inclined to accept the increased costs as a necessary expenditure.

In short, technical reports on the Santa Barbara quake soon were forgotten and the previous state of public apathy toward the school safety problem was restored quickly. If the public had appreciated at this time how nearly correct were the findings of the small group of technically minded men who advocated conservatism of design and lateral strengthening of buildings, the expenditure of even the extra 16 per cent might have been accepted as a truly economic measure. With school plants now totaling about $77,000,000 in value, Los Angeles is spending $13,400,000 for rehabilitation and $12,188,000 for the replacement of old buildings. In addition to replacements, new buildings are costing about $8,000,000 and land they require is costing $1,100,000 more.

Instead of a swing toward greater safety after the Santa Barbara quake it almost would appear that the real effect was a period of relaxing safety measures. In part it may have been economic pressure that showed effect upon the design of buildings, but from whatever cause building ordinances were more easily complied with and concessions were made to landscape gardeners with less concern as to effect on foundations. For example, shrubbery was massed at irregular points about buildings, in some cases resulting in unequal use of irrigating water with consequent variations in the bearing power of the soil. There were examples of extensive softening of footing soil on one side of a building while that on the other side was left dry and hard against a drained playground. This is cited as typical of the complacent attitude that entirely disregarded seismic hazards.

Public apathy reversed

The lack of concern about the school safety problem and the peaceful apathy of the public toward it vanished over night with the Long Beach earthquake. This was an electric signal for the reversal of public opinion and the response was instantaneous. There was immediate demand for safe schools regardless of cost.

With the support of this strong public sentiment now available there were prompt moves on the part of state, county and city governments to estimate the extent of damage, to determine whether there was risk in occupying the less damaged structures and to prepare laws and ordinances for the regulation of repairs. Boards, commissions and committees with varying degress of permanency, fields of operation and amount of authority were appointed; within a few days after the earthquake, assurance was forthcoming on every hand that the public demand for safety in schools would be speedily and effectively met.

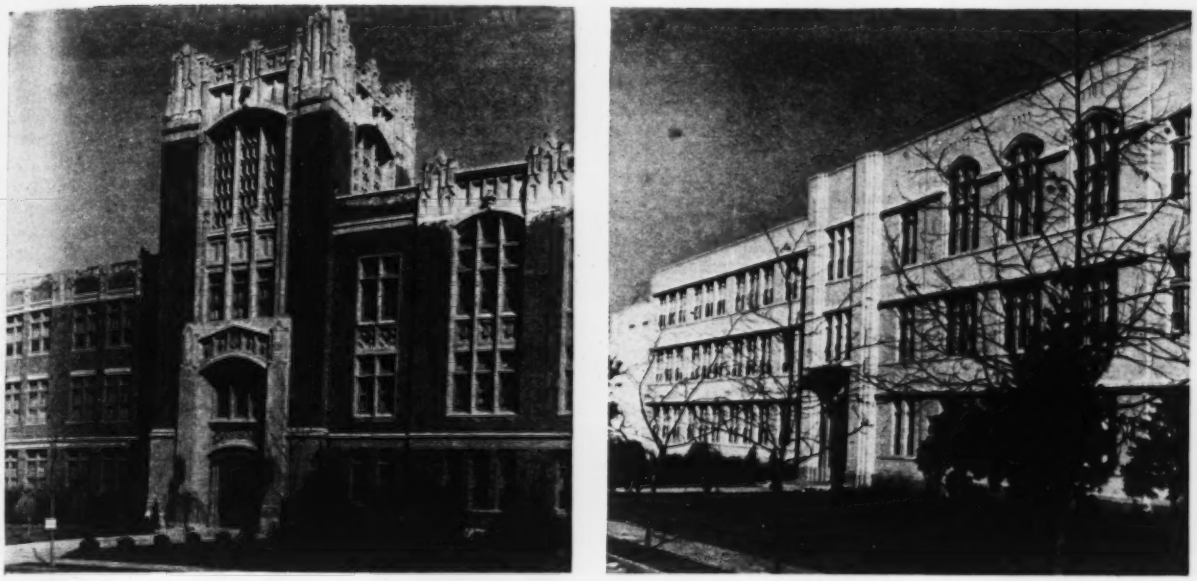
Three important influences were factors in the situation at this time. Perhaps the most important of these was appendix *A* of the Uniform Building Code, California edition, which contains the net results of several years of work on the problem of making structures earthquake resistant. Fortunately, a capable committee of structural engineers had been at work on this problem long enough to have evolved a comprehesive set of rules and requirements for seismic-resistant design, ready for application when the emergency arose. Within a month after the Long Beach earthquake the division of architecture of the California Department of Public Works issued a bulletin of rules and regulations covering the construction of public school buildings. These rules adopted appendix *A* bodily as the standard of construction that was to be the legal requirement in all subsequent operations.

Next in the importance of its influence on rehabilitation program was the work of the board of consulting engineers appointed by the Los Angeles Board of Education. This consulting board worked in close connection with the school superintendent and the school architects in the selection of the damaged schools which should receive first attention and in determining the desirable sequence in the rehabilitation program.

Third, a bulletin on "Earthquake Hazard and Protection," was published by the joint technical committee on earthquake protection, a group of outstanding men headed by Dr. Robert A. Millikan, California Institute of Technology. This report was valuable from a scientific and engineering aspect but because of the authority and standing of those who signed it, it was even more valuable in swinging public opinion toward greater emphasis on seismic-resistant design.

New objectives

When the lessons of the Long Beach disaster had been fully analyzed and understood the Los Angeles Board of Education found itself confronted with a series of entirely new objectives, each of which it was necessary to attain within the restrictions of city and state provisions and many of which were in direct conflict between ways and financial means. The first objective, of



BEFORE AND AFTER VIEWS of George Washington High School, Los Angeles, reveal (left) cracks in tower caused by earthquake and (right) the repaired building in which the most apparent change is the elimination of the tower and the decorative parapets.

course, was safety of the children: accordingly, all school sessions were suspended for the time being. The next objective was to reduce the suspension period to the minimum consistent with safety. This resulted in a hasty but careful survey under the direction of the school board. The chief objective was to locate those buildings which were safe for immediate occupancy, beyond all doubt, leaving as a secondary consideration the determination of extent and nature of damage.

Another objective was to provide temporary housing, on school property if possible, where pupils probably would be safe in case of subsequent earthquakes. Redistricting the badly shaken areas and the assignment of short sessions to available safe buildings was a difficult problem under the pressure of time. Yet within the second week after the earthquake many schools had been reopened. After a school was reopened the same organization that had made the preliminary inspection continued its work in greater detail, gave attention to the nature and extent of the damage and to the structural and economic means of repair. Records of this survey were preserved in the form of preliminary plans and specifications which proved to be of value as the work progressed.

While these preliminary objectives were being rendered clear and definite there was a cloud in the background which looked threatening for a time. The problem of what to do was taking definite shape, but the financing of so great a task within a period of unprecedented depression at times appeared to be impossible. Assuming that the rehabilitation program would occupy a period of more than 2 years, there was in sight $9,287,000, of which $6,808,000 was represented by unsold and apparently unsalable bonds. Thus available funds appeared woefully inadequate when the estimated cost of rehabilitation, compiled by the consulting engineers, was placed at a total of nearly $31,000,000.

The Board determined to ask for an issue of bonds which would be more desirable to investors than those on hand. Failing in this attempt it was necessary to look to other sources of financing. This source was found in the PWA under a program that liquidated the old existing bonds and carried a grant of 30 per cent. A second attempt to raise bonds on the promise of a 45 per cent federal grant was successful, and when the funds from all available sources were assembled they amounted to $34,688,000.

With available funds in sight the Board expanded its architectural section to include a complete estimating division and an entirely new division whose function was to coordinate work of the architectural section with PWA authorities. Also the building and inspection division of the architectural section was expanded to handle details of construction and supervision.

Deciding on repair sequence

In the rehabilitation program the plan was to segregate jobs in which new construction predominated from those in which little architectural treatment was required. For work in the former class contracts were let to architects who in turn employed the structural engineer. On the other hand, rehabilitation jobs in which the primary requirement was reinforcing the existing structure were let to structural engineers, and an architect was named to look after architectural features and coordinate the work as a whole.

The order in which jobs were assigned was a problem with many complications; on no two sites were the same set of conditions ever presented in anything like a similar order. Always the chief objective was that of safely housing the greatest number of pupils. In reaching this decision the possibility of redistricting always had to be considered. This was complicated in badly shaken areas by transportation and street safety difficulties as well as by major elements of the problem, such as the seriousness of the damage in one district as compared to the undamaged classroom area remaining in a group of adjacent districts. In some cases undamaged classrooms could not be used because of some hazard in the corridors or other lines of communication adjoining.

The danger from subsequent shakes had to be kept in mind constantly and for this reason every estimate of degree of safety always involved an element of prophecy. Thus the order or sequence of the rehabilitation jobs was one of the most difficult problems to solve. In reaching final decision it was a case of utilizing "all hands and the cook"—the Board of Education concentrated on the problem, the board of consulting engineers rendered valuable service and final decisions were reached only after taking into account all angles of the situation.

The 12 to 16 per cent of first costs estimated after the Santa Barbara earthquake as necessary to provide seismic protection doubtless was conscientiously made and well founded at that time.

In the intervening 10 years, however, changes have taken place that reduce the necessary costs. During this time the knowledge of earthquakes and of their effect on structures has been widely disseminated among engineers of this locality; the minimum intensity against which provision must be made has been established by law, and the technique of making the necessary engineering calculations has been improved and facilitated by the development of many labor-saving devices and methods, including carefully prepared approximations. While much of this change might be considered largely psychological in nature, it has had no small influence in reducing the cost of providing resistance to lateral forces.

Aside from the problems of the structural engineer the architect has learned that lateral resistance is greatly enhanced by the simple planning of a building without lessening the architectural beauty; unnecessary offsets and irregularities now are eliminated. Contractors have found that many of the precautions aimed toward continuity of the structure may be taken at no cost increase and with only a slight change of mental attitude. In these and in other ways it has been found that the cost of lateral strengthening is much less than it was at first believed to be.

It is still impractical to set a fixed percentage that represents a fair allowance for seismic resistance. In some cases the extra cost has not exceeded 3 per cent. This is in class *A* buildings with concrete joist floor and roof systems. It is believed that adequate lateral resistance may be provided in class *B* buildings at an increased cost of about 8 per cent, and it is probable that as the class of the building goes lower the cost of adequate lateral strengthening is proportionately increased. It is likely that the average cost today does not exceed half the percentage estimated 10 years ago. Moreover, the experience of recent years has developed many little tricks and methods in design and in construction which contribute to lateral strength by means unknown a decade ago.

OTHER ARTICLES REFLECTING MODERN EARTHQUAKE DESIGN PRACTICES

Reconstruction Work in Long Beach ..... Feb. 22, 1934, p. 263

California Progress Against Earthquake Hazard..... July 5, 1934, p. 5

Earthquake – Resistant Construction Applied to California Schools.. Dec. 19, 1935, p. 856

Repairing Earthquake Damage

Rehabilitation problems demanded analytical methods without precedent and resulted in a classification of buildings according to seismic resistance and in five schemes for repairing quake damage—Rehabilitation costs

By J. E. Byers

Chief Structural Engineer, Los Angeles Board of Education

REHABILITATION and suitable strengthening of existing buildings to increase their resistance to horizontal forces was a new problem in 1933 when a very comprehensive program was undertaken in Los Angeles for safeguarding pupils in public schools against earthquake dangers. The problem still is new—at least phases or details without precedent still arise on almost every job undertaken. Many of these problems involve the most searching analyses; satisfactory solutions require the best judgment of architect and structural engineer. The work started with preparation of an estimate on the cost of making all buildings in the Los Angeles city school system earthquake resistant. Even at the outset it was apparent that so great a project could not be undertaken all at once. It was decided, therefore, to classify the structures into groups according to their relative resistance to horizontal forces as well as to fire and panic hazards. By following this plan the more serious risks could be given attention first.

When this work was begun in 1933 none of the existing buildings was of a design calculated to withstand earthquakes. Analyses showed some of the schools to be stronger and more rigid than others and hence to possess in much greater degree inherent resistance to horizontal forces. Thus it was logical to divide the buildings generally into several classifications or types in which could be grouped those of comparable resistance to horizontal forces, a quality now commonly termed "seismic resistance."

Seismic resistance rating

Buildings of very similar design may differ materially in detailing, particularly in joints and bracing. In masonry construction, particularly, the ability of the contractor and his familiarity with the minor details that contribute to rigidity have a bearing on seismic resistance. However, it has been found sufficient for general purposes to adopt seven general classes or types into which all existing school buildings in Los Angeles could be grouped. These are defined as follows:

Type 1—Class *A* buildings with reinforced concrete or structural steel frames and concrete floors and roofs are rated as type 1. Most of these buildings are two and three stories high, though two are much higher; one has a height of ten stories.

Type 2—Class *B* buildings of concrete or brick exterior walls with concrete corridor floors and stairs, a concrete slab over the top story corridor and stairs and reinforced concrete bond beams at each floor line are rated as type 2. In this group the corridor walls may be of concrete or brick and in some cases are of skeleton frame with tile or metal lath and plaster-filled walls. The classroom floors have wood joists, wood-finished floors and metal lath and plaster ceilings and partitions.

Type 3—The third type includes the same buildings described in type 2 except that the concrete slab over the top story corridor and stairway walls does not exist. This cover slab is a factor in fire protection as well as in earthquake resistance.

Type 4—The fourth type also is similar to type 2 except that the concrete slab over the top story corridor and stair wall and also the bond beams at the floor lines that are required in type 2, are missing.

Type 5—The fifth type includes structures which have exterior bearing walls of brick, tile bearing walls for corridors, concrete corridor floors and stairs, wood joists and wood-finished floors in the classrooms and ceilings and partitions built of metal lath and plaster.

Some of the buildings of this type have bond beams and some do not.

Type 6—Buildings of the sixth type have exterior and interior bearing walls of hollow tile but in other respects are similar to type 5. Some buildings in this classification were vencered with face brick on exterior walls.

Type 7—Buildings grouped in type 7 have bearing walls of brick or hollow concrete blocks with open truss roof above and space divisions formed by wood studding partitions. In this class some buildings have truss spans of considerable length either of wood or steel. The walls are high with large openings such as occur in auditoriums, gymnasiums and shops. Included in this general class also are a few masonry buildings of miscellaneous types varying slightly from the description just given. However, the number of such structures is not large.

Types 3 to 7, inclusive, are in general of class *C* as defined by Los Angeles building and safety ordinances.

Finally, not classified as a type, are wood frame structures, some old and obsolete in arrangement, presenting greater fire hazards than do the masonry buildings; the fire hazard is notably greater when they are two stories in height. (These two-story wood frame structures were built before the existing Los Angeles City building ordinance, which prohibits a two story school building of this class, went into effect. In fact these buildings have been in use more than 20 years.) Also there are a large number of wooden bungalows of temporary nature and other miscellaneous wood buildings. By reason of their lightness these wood frame structures present less earthquake hazard than do the masonry buildings.

The foregoing types are numbered in the order of their seismic resistance. Consequently in beginning the rehabilitation program laid out in 1933 attention was given first to the weaker types: those damaged in the earthquake were considered first, next came those which had inadequate or questionable foundations. Up to the end of 1936 some 220 buildings in the Los Angeles school system, built before the 1933 quake, had been analyzed for seismic resistance, and rehabilitation had been finished or was still under way on about 95 per cent of them.

When work is started on a building, the architect and the structural engineer for the job are appointed by the Board of Education and plans and specifications are prepared. Architect and engineer work under separate agreements and the fee is based upon the cubical content of the building as measured from the average depth of the footings to the average roof height. This basis of scaling the pay was found to be the most equitable; buildings of the same floor area varied considerably in reconstruction costs.

REHABILITATION COSTS UNDER DIFFERENT SCHEMES

Scheme of Rehabilitation	Financial Program	Number of Buildings Averaged	Average Cost per Cu. Ft. (cents)
One	First	3	10.6
Two	First	4	10.0
Three	First	20	9.75
Three	Second	20	12.7
Four	First	14	11.6
Four	Second	6	14.5
Five	First	4	14.0

Using the average footing depth as the lower limit in computing cubical contents was a convenient means of making allowance for the fact that in some buildings the foundations required very little if any attention and in others foundations involved much calculation. Computations sometimes were quite as extensive on class *A* buildings requiring only a small expenditure to accomplish the desired seismic resistance, as in the case of a building of the same size where the cost of repair was very much greater.

When the architect and the structural engineer submit their preliminary drawings and calculations an estimate of cost is made and decision then is reached as to whether it will be more economical to demolish the building and construct a new one or to proceed with rehabilitation. In some cases the new building is selected even where the first cost is greater because annual operating cost may be more important than first cost. A new, class *A* structure has a longer expected life, lower maintenance and service costs, lower insurance premium and presents less fire hazard than do rehabilitated class *B* structures. In general, when the cost of strengthening and rehabilitating becomes more than 65 per cent of the cost of replacement the decision has been in favor of the new structure.

Five rehabilitation schemes

A notable point that developed in the course of this survey is that the cost of strengthening a weak building in a low grade classification is about the same regardless of whether it has suffered earthquake damage. In other words, buildings of rather low construction standards, when damaged by earthquake, did not cost much more for rehabilitation than did buildings of the same type on the seismic resistance scale which happened to be in a zone where the shock intensity was not destructive. Some of the factors that establish the limit to which it is economical to go in rehabilitation are: the type of footings; the foundation material; the location of the building on its site; the arrangement of plan of the building to other buildings on the site; obsolescence; and appointments such as fixed equipment and finish which might be saved.

Methods of strengthening buildings are varied in accordance with the requirements of each case. In some cases after plans and specifications were worked up it was decided that the cost of the project was excessive and some entirely new scheme would be adopted to lower the cost while still providing the necessary strength. Now that a large number of rehabilitation projects have been completed it is possible to group into five general classes the schemes that have been developed for the school building strengthening.

Scheme 1—A framework of structural steel columns and beams has been employed in what is classed as scheme 1. Masonry walls are chased horizontally and vertically to provide space in which to place the steel which generally includes framed vertical bents and in some cases trussed vertical bents and trussed horizontal members. The horizontal loads are transferred to these wall bents or columns by means of horizontal beams or trusses placed in the horizontal plane of the floors and roof. Masonry walls are tied to these new members by means of concrete or a shotcrete blanket or by placing the vertical and horizontal members close enough to enclose units of masonry so small that they can be held in place safely. This scheme further involves the concentration of vertical loads on the footing walls at the columns, which are strengthened where necessary. The strengthening may be by means of a new distributing beam at the top of the foundation walls or the addition of longitudinal reinforcement along the top and bottom of the existing foundation wall where shotcrete is placed around the steel and bonded to adjoining concrete. Vertical cracks in the old walls are chased out and filled with shotcrete.

The repair of cracked corridor slabs or beams likewise is by means of chases which must be ample in size and free of all loose or fractured concrete so the shotcrete will have an adequate bond. The addition of beams and trusses in the horizontal plane must provide adequate mechanical anchorage to masonry walls, floor systems and roofs to transmit shear, compression and tension. Finally, the deflection of these members under the assumed loads must not be so great that the masonry walls, new or old, will be in danger of fracture or of having any of their parts thrown out of line by transverse motion. The permissible deflection of a masonry wall as allowed by the State Division of Architecture is 1/600 of its length or its height (whichever is greater) between supports. Thus it will be seen that the working unit stresses of these structural steel members often is quite low in order to keep the deflection below the allowable maximum.

Scheme 2—Classed as scheme 2 is a type of strengthening which uses rigidly connected reinforced concrete frames or

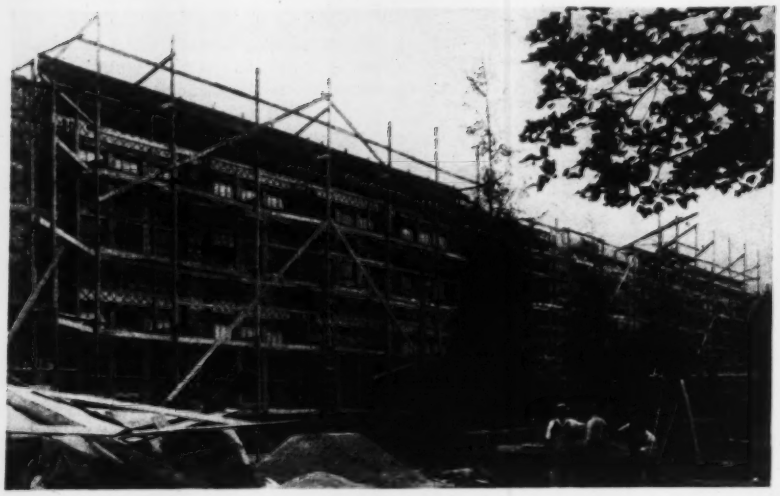


FIG. 1—EXTERIOR WALL reinforcement work on the Thomas A. Edison Junior High School consisted of stripping off 4 in. of brick, putting on vertical and diagonal reinforcing bars and covering with a 4-in. thick coating of shotcrete.

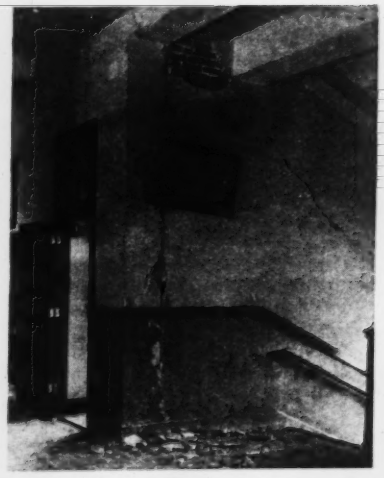


FIG. 2—DIAGONAL CRACKS in wall panels, at right angles to one another, are typical of earthquake damage in frames with inadequate bracing. This picture shows the second floor corridor, Thomas A. Edison Junior High School main building.

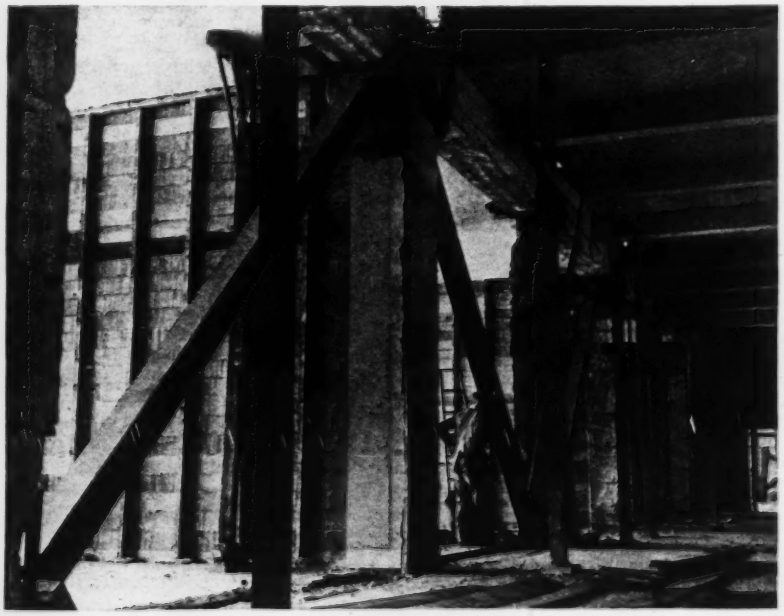


FIG. 3—INTERIOR WALL reinforcement details in the Thomas A. Edison Junior High School included diagonal bracing of structural steel beams between existing concrete columns in corridors.

bents instead of the structural steel used in scheme 1. The concrete may be poured in place or put in as shotcrete; the latter generally is used. In work of this sort the designer and the detailer must be very painstaking in proportioning the new members so there will be adequate clearance around the reinforcing steel. It has been found that in this type of work the percentage of reinforcement is quite high, especially where the walls are as much as 17 in. thick.

Scheme 3—The third scheme is the one that has been most frequently used because of the large percentage of brick construction in existing school buildings at the time of the quake. It consists of stripping 4 in. of brickwork from the outside of all brick walls, chasing walls vertically for columns and sometimes horizontally for beams, placing reinforcing steel in these chases and then filling in with shotcrete. This method provides a system of reinforced concrete columns and beams with a blanket approximately 4 in. thick over the entire outside wall surface. In the usual classroom building the concrete corridor floors are strengthened so that they act as a distributing medium to all cross walls and end walls. These walls then become shear walls, usually with very low unit stresses. They are very stiff and consequently have but small deflection under the designed load.

Where the slab over the top story corridor does not exist, a new reinforced concrete slab is placed there to provide a diaphragm for carrying horizontal load at the roof or ceiling line. In most instances brick or tile buildings have concrete foundations and concrete foundation walls up to the level of the first floor or at least to the ground level. In some cases the foundation walls as originally built have brick down to the top of the spread footing. Where this occurs, the columns and wall blankets put on in rehabilitation are carried down to the footing, otherwise they rest on the top of the concrete footing walls to which they are anchored by dowels sulphured or grouted into drilled holes. In addition, the tops of these foundation walls are cut to provide shear keys for bonding with the concrete that is shot or poured into place.

In some instances cross walls were so far spaced in original construction that additional walls were required in rehabilitation; these generally were of poured concrete with reinforcing tied to the new shotcrete columns and beams at all intersections. The reinforcing of existing corridor slabs which are to act as diaphragms or transmitting mediums usually is accomplished by adding longitudinal reinforcement at its outer flanges along the corridor wall. Steel so placed is covered with shotcrete to form a beam or haunch, which thus is tied to the new wall construction and is bonded to the old concrete

slab. Where the old slab is of doubtful quality a new reinforced blanket is placed on the under side by the shotcrete process. Wherever cracks occur they are chased out before the new material is put on.

Brick or tile walls may be reinforced by poured concrete in lieu of shotcrete. Considerable study and discussion attended the attempt to pour these thin blankets which usually have been placed in lifts about 3 ft. high because of the narrow spacing to be filled and the small quantity of concrete required at any particular spot. The custom has been to bring concrete onto the scaffold in buggies and there transfer it to coal scuttles except at the columns where the larger space made it feasible to pour directly from buggies.

In the concrete poured against brick it was necessary to use more water than ordinarily would be permitted. Even where the brick had been thoroughly wetted and kept wet for 24 hours or more immediately preceding the placement of concrete, large quantities of water were absorbed from the mix. A slump of 8 or 9 in. was found necessary and the mix was made up with about 1 part of portland cement to 4½ parts of aggregate not exceeding the ¾-in. size. The use of the large quantities of water on the brickwork had a disadvantage in that the bricks and particularly the mortar are quite porous and moisture sometimes works through to the inside of the wall, softening the plaster and causing it to remain damp for a long time. In some cases the plaster had to be removed to allow the walls to dry out. If the walls are kept wet for a period of eight days after forms are removed the resultant shrinkage will be no more than shotcrete placed over brickwork. This may be accounted for by reason of the moist blanket of brickwork which produces an ideal curing condition.

Scheme 4—Classed as scheme 4 is a type of reconstruction used where exterior brick walls are quite heavy, show highly inferior workmanship or have narrow piers and large openings for windows. In such cases the exterior walls are removed entirely down to the footings (Fig. 6) and new concrete walls are poured in place. The interior cross walls and corridor walls generally are stripped of 4 in. of brick and treated as described in scheme 3 with the reinforcement tied to the new concrete walls at all intersections. Otherwise, scheme 4 follows in general the methods used in scheme 3.

Scheme 5—A fifth method, used where experience with a foundation has shown it to be inadequate to support the heavy masonry construction, involves the removal of the masonry walls and substitution therefor of wood studding walls. When this is done the exterior walls are finished outside with cement plaster while metal lath and plaster are used on the interior. This

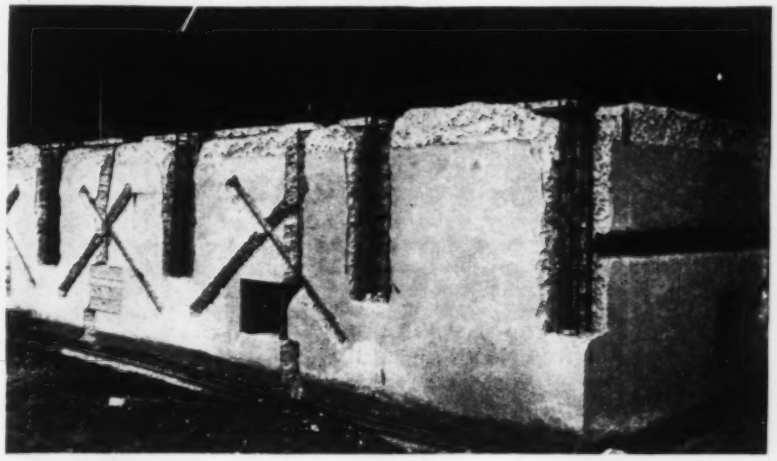


FIG. 4—FOUNDATION WALL reinforcement in the 79th St. School assumed the form of steel bars and cages embedded in plain concrete and carried up to the first floor level.

FIG. 5—HORIZONTAL TRUSSES of steel were put in the ceiling of the Graham School corridors to distribute horizontal load at second floor level to cross and end walls.

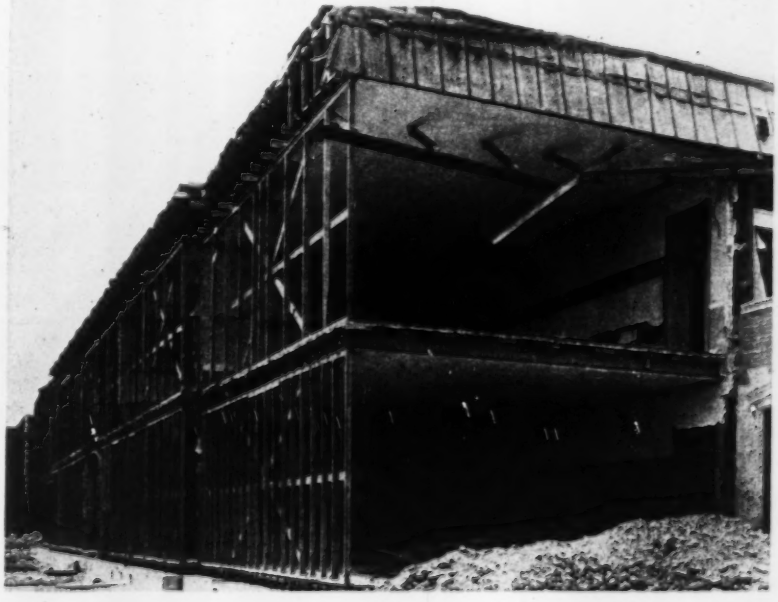


FIG. 6—EXTERIOR WALLS were entirely removed from the Gardena High School. Floors and roof were left in place, shored up, awaiting forms in which new concrete walls were poured.

construction is allowed a 1-hour fire rating by the Board of Fire Underwriters.

Where such a building originally had two stories, the change from masonry to wood bearing walls also includes reducing it to a one-story building. For reasons of fire and panic safety two-story wood school buildings are prohibited by Los Angeles city ordinance. In the reduction from two stories to one, existing second floor joists and flooring are shored up and are used as supports for the roof of the rehabilitated structure. Usually the plaster on the second floor joists can be saved. There were a few buildings particularly adapted to this scheme in that they were of one story and had exterior tile bearing walls with wood stud bearing walls and partitions on the interior.

General considerations

Certain general items are applicable in all five rehabilitation schemes. Masonry walls can be strengthened most economically by working on the outside of exterior walls and on the corridor face of corridor walls, thus saving the plaster and paint, avoiding necessity for removal and replacement of the trim and leaving fixed equipment undisturbed. Consequently, wherever possible, chases for vertical columns were made to leave 4 in. of brick or the inner wall of hollow tile. New supports were provided for all floor joists and roof framing, spanning between columns, in the form of structural steel members or, where space permitted, in the form of reinforced concrete. Likewise the concrete corridor slabs finally are carried on the new columns and beams when the building is completed. The new columns and beams are therefore calculated to carry all floor and roof loads even if all the old brick or tile were removed. However, brick and tile allowed to remain in place is assumed to carry its own weight down to the foundations.

Anchoring floors and roofs

Floor and roof systems are fastened rigidly, by means of anchors, to the new construction and plans usually call for anchors 4 ft. on centers, bolted to the joists. These anchors between points of fixity must figure for both compression and tension and usually are constructed by bolting flat irons to the joist and anchoring the other end into the new concrete or shotcrete by means of a steel pin tack-welded in place through the flat iron.

The roof and floor systems also are anchored to the walls to provide for shear in the plane parallel to the walls. Where the transverse diaphragm is located at the ceiling of the second story, the roof framing system must be anchored and braced adequately to this diaphragm in transverse and in longitudinal directions to provide against any horizontal movement.

Particular attention is paid to anchoring or tying a building transversely along the same member. Joists and rafters are anchored or tied at each end. Likewise continuous girders are connected at joints by means of steel or wooden splice plates. Mechanical and electrical pipes and conduits are moved wherever they would pass through newly placed columns or would extend vertically into the 4-in. or 5-in. wall blankets. Wherever existing concrete or steel lintel ends project into new columns, specific details are provided to show a connection between the old and the new work and the cutting necessary to install the new work.

Rehabilitation costs

The work of the rehabilitation of the Los Angeles school buildings to date has been done under two programs. The first program was undertaken in 1933 and was substantially completed in 1935 at a total cost of $12,204,106 which included a grant of 25 per cent of this amount from the PWA. The second program was begun in 1935 and is now well on the way to completion. The total amount of this program is $22,532,727 of which the PWA furnished 45 per cent as a grant.

All of these funds were not expended for rehabilitation or replacement as some new plants including the necessary land constituted a large part of the second program. Comparing the unit costs of the second program with those of the first program we find them considerably larger by reason of causes beyond our control.

Rehabilitation cost necessarily is subject to wide variation because of the many factors involved other than the structural work. After all, the buildings must be suited to their function and must furnish adequate appointments for the service to be rendered. The non-structural work in some 20 of these buildings selected at random from the last program cost from 4 to 4½ cents per cubic foot, depending upon the requirement in the amount of new finish including plaster and paint, the added mechanical and plumbing equipment and, also, the re-arrangement of offices and other spaces. Typical costs are given in the table on p. 363.

Unit cost basis

The reasons for rating costs in terms of cubical content rather than floor area are principally the wider variation there would be in unit costs on the latter basis. This variation may arise from the percentage of contents in a basement, in the roof space, in the height from ground level to the first floor, or in the ceiling heights. All of these items affect the cost of the building reconstruction and yet the unit cost in terms of the cubage is quite comparable. Where the cost per cubic foot is within reasonable limits the cost per square foot may be so high as to cause a rejection of the rehabilitation in favor of a new building.

The unit costs in the table refer in all cases to the contract or construction costs and do not include the cost of the preparation of plans, the inspection or supervision of construction, soil and material tests, or the legal and accounting costs.

Municipal Costs Rise as Population Shrinks

CITY GOVERNMENTS are slow to keep up with population changes. As a consequence, according to William F. Ogburn, professor of sociology, University of Chicago, when the population is on the decrease, services become more expensive to the taxpayer; and when the city is growing, before it is generally recognized, municipal services may become uncomfortably inadequate for the population served.

Professor Ogburn first noticed disproportionately high per capita costs (45 per cent more in shrinking cities) when he was examining police figures in a comparative survey of the social characteristics of decreasing and increasing cities. Results of his survey appear in *Public Management*, official magazine of the International City Managers Association. Upon examining figures for other municipal services, Professor Ogburn found the case repeated: Costs of fire departments were 65 per cent greater per capita in the shrinking communities than in the growing ones; of street cleaning departments nearly twice as large; of care of parks and trees about 50 per cent higher; of education about 20 per cent greater. Even the cost of inspection of buildings, wiring, plumbing and boilers was about 50 per cent higher. Costs of library service, health conservation and charities likewise were higher in the decreasing cities. Altogether the difference totaled as much as 15 per cent.

It is Prof. Ogburn's belief that governments of increasing cities do not anticipate in actual budgeting practice the needs of the larger future populations, and that the governments of decreasing cities do not anticipate the diminished needs of smaller future populations.

Changed Concreting Practice Speeds Road Widening

Experience in Wisconsin with widening and resurfacing indicates the superiority of single over separate concreting operation.

By A. T. Bleck

Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

THE PROBLEM of progressively rehabilitating its main roads to carry more and faster traffic faces Wisconsin as it is facing other states. In general, reconstruction is not required because the existing road surfacing has failed structurally, for in many instances the old pavement is still strong and stable; it is necessary because the highway is inadequate in carrying capacity or does not provide safe operation due to sharp horizontal and vertical curves. The work to be done is enlargement and improvement.

The fundamental plan for reconstructing an individual road depends of course on the type and volume of reconstruction necessary and particularly on the amount of grade and curve revision that is required. If this is considerable, leaving only short stretches of the old pavement that can be utilized, it is probably as well to dismiss thought of salvaging any of the old surface and plan to reconstruct the road entirely. If, on the other hand, there are only minor corrections in alignment and only a few places to regrade and the problem is primarily one of providing additional width, it can be very effectively solved with some saving in cost either by widening or by widening and resurfacing—especially if the old pavement appears to be in a fairly good condition. Several improvements of this nature have been completed in Wisconsin during the past few years, and the significant processes will be outlined.

First trial plan

The first work was on the state trunk highway (No. 42) beginning at the Racine-Kenosha county line and extending south 2.7 miles, towards the city of Kenosha; construction was started in the fall of 1932 and completed the following spring. A portion of the old concrete pavement had been previously widened 3 ft. on its west side or from 16 to 19 ft.; the balance was already 18 ft. wide. The new work consisted of widening the pavement to 30 ft. and resurfacing it with concrete.

As an interurban trolley line had previously been removed on the east side of the old pavement, all the widening was placed on that side. As shown by Fig. 3 a slab 11 or 12 ft. wide and 7 in. thick was constructed as a separate operation, prior to resurfacing. This slab was concreted by conventional methods and finished to a regulation finish with a belt. An expansion joint was placed at every point where an expansion joint occurred in the old pavement. No provision was made to anchor the new widening to the old pavement except that the edge of the old slab was undercut.

After the widening was completed, resurfacing was started. Forms were placed on each side, the top of the forms being set at an elevation that provided a minimum thickness of 5½ in. of concrete over the old surface and the widened portion; in setting the forms such minor corrections in grade were made as were necessary to provide a smooth profile on the finished work. A little difficulty was encountered in maintaining a uniform width of 30 ft. because the old pavement had been constructed with variations in width of an inch or more which gave some trouble in operating the finishing machine and other equipment riding on the forms.

In general, no effort was made to prevent a bond between the old and new surfaces, except that in a few short sections building paper was placed on the old surface to study its effect. The extruded joint and crack filler material was shaved down to the old surface, dust and other debris were swept off and the new concrete was placed. This was struck off 2 in. below the finished surface and a mesh of No. 4 wire spaced 6 in. on centers in both directions was placed to run continuously across the width of the pavement, through the longitudinal center joint and through the transverse contraction joints.

The balance of the concrete to complete the section was placed, struck off by a finishing machine with one screed 30 ft. wide, and then fine finished by longitudinal floats and belts. It was found that although the finishing machine had only one screed it could keep up nicely, because even with good efficiency the rate of progress ahead of the placing operations did not exceed the speed of the machine.

Joint revision

Longitudinal dummy joints were constructed by a machine with two cutters placed 10 ft. apart. In the original design it was planned to place 1 in. expansion joints at intervals of

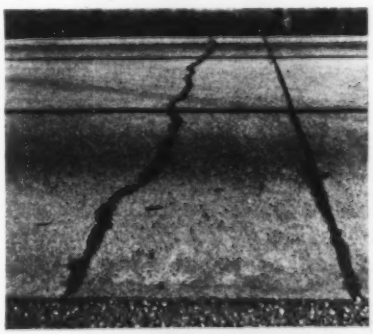


FIG. 1—CRACK, typical of those found in roads resurfaced by early methods, concluded to have been caused by failure to match joints in old pavement and new resurfacing slab.

FIG. 2—(Below) A MODERN 30-FT. PAVED ROAD produced by widening and resurfacing an old 19-ft. concrete road in southern Wisconsin.

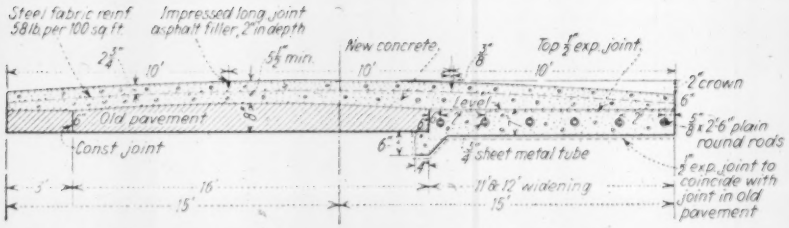
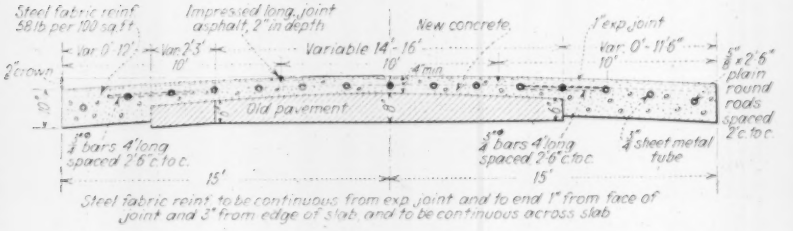

Steel fabric reinf 58 lb per 100 sq ft
Impressed long joint asphalt filler, 2" in depth
New concrete
Top ½" exp joint
2" crown
Old pavement
level
⅝" x 2'6" plain round rods
Const joint
¾" sheet metal tube
1" exp joint to coincide with joint in old pavement
11'&12' widening

FIG. 3—REVAMPING PROCEDURE when the widening strip was constructed first and then the widened road was resurfaced its full increased width.

FIG. 4—REVISED RECONSTRUCTION procedure in which the old road is widened and resurfaced in one concreting operation.


Steel fabric reinf 58 lb per 100 sq ft
Impressed long joint asphalt, 2" in depth
New concrete
1" exp joint
Variable 14'-16'
2" crown
Old pavement
⅝" x 2'6" plain round rods spaced 2' c to c
¾" bars 4' long spaced 2'6" c to c
¾" sheet metal tube
Steel fabric reinf to be continuous from exp joint and to end 1" from face of joint and 3" from edge of slab, and to be continuous across slab

83 ft. 9 in., with two contraction joints between at 27 ft. 11 in. intervals, regardless of joints in the old pavement, and about one half of the resurfacing was constructed with this joint arrangement. At about this point the work had to be shut down for the winter and the following spring, when operations were about to be resumed, it was noted that transverse cracks had developed through some sections of the resurfaced portion at regular intervals of about 50 ft., varying only by a few tenths of a foot. The cracks were located without reference to the proximity of a resurfacing expansion or contraction joint, some of them being only a few feet from such a joint; such a crack is shown in Fig. 1.

As the old pavement had expansion joints at about 50 ft. intervals it was immediately suspected that these cracks occurred over the old joints, and the design was then varied to place the new joints over the old joints, varying the spacing to obtain panels about 25 to 35 ft. long. As the old pavement surface was somewhat irregular in contour it was determined to use poured-in-place expansion joints, so that a complete separation could be had.

Concrete practice

The concrete was proportioned by weight, using separated sizes of coarse aggregate. In the widening three sizes of coarse aggregate were specified, ½ to 3/4 in., 3/4 to 1½ in., and 1½ to 2½ in., with a cement content of 1.35 bbl. per cu. yd. In the resurfacing, because of the thinner section, only the two lower sizes of aggregate were permitted, and the cement factor was raised to 1½ bbl. per cu. yd. The resurfacing because of variations in thickness, was measured and paid for on a cubic-yard volume-in-place basis, the yardage being calculated from the absolute or solid volume of the aggregates and cement, to which was added 85 per cent of the volume of water, including the moisture in the aggregates. The factor of 85 per cent is more or less arbitrary and is contemplated to take into account the water loss in the concrete subsequent to placing, but is based on some experimental work done along these lines.

After completing the resurfacing the total volume of the concrete was computed on the basis described, and it was found that the average thickness was about 7⅛ in. or about 1⅛ in. thicker than the minimum specified.

Based on experience gained on this first operation, the design of subsequent work was altered as shown by Fig. 4. The thickness of the resurface course is reduced to a minimum of 4 in. and the widening is placed at the same time and monolithically with the resurface course. Cost is saved by this design because the total volume of concrete is reduced; one placing of a set of forms is saved, and a truer alignment of the edges of the pavement is permitted. The widening in this case is uniformly 10 in. thick, and 3/4 in. round dowels 4 ft. long spaced 2½ ft. on centers, are placed over the edges of the old slab. As in the earlier widening work, all of the concrete used is measured on a cubic-yard volume-in-place basis.

Two roads of this design have been constructed and neither on these nor on the one previously described have longitudinal cracks developed over the edges of the old slab, or over the joint between the widened portion and the old slab. One of the roads (No. 42) is between the city of Kenosha and the Illinois-Wisconsin state line, and the other (U.S. 141) is from the Milwaukee-Ozaukee county line north about six miles. Two resurfacing operations of a similar type have also been completed in the cities of Racine and Superior where the street grades were found to permit such construction. On the Racine operation it was found necessary to remove the old base at intersections properly to match up the new work with the existing street grades and maintain a minimum depth of new pavement.

As stated previously, when grade and alignment conditions are right it is felt that economies can be effected by widening and resurfacing since the cost of removing the old pavement is saved and an apparently satisfactory strength of slab is attained with a lesser volume of concrete.

Parking and Traffic Statistics For Chicago

SINCE 1931 off-the-street parking facilities in the central business district of Chicago have increased from 135 to 212 establishments of which 166 are vacant lots and 46 are garage buildings, according to survey by the traffic engineering division of the city's Department of Public Works. In 1927 there were 60 establishments of which 34 were lots. In the 1936 facilities 28,158 cars can be parked, (17,386 in lots and 10,772 in garages) compared with a 23,217 total capacity in 1931 (11,025 in lots and 12,192 in buildings). The increase in lot storage and slight decrease in buildings indicates a definite trend to lower price storage. Use in 1936 was 90 per cent compared with 75 per cent in 1931. In the Loop 2,000,000 sq.ft. of area is devoted to parking. Cordon counts of all people entering the district on a typical week day in May from 7 a.m. to 7 p.m. were 801,798 with but 722,539 leaving. In-and-out passengers by automobile were 215,849 and 205,765 respectively; by motor bus, 46,812 and 41,171; by steam railroad, 92,144 and 75,367; by elevated, 200,212 and 164,845; by street cars, 246,781 and 235,391 respectively. Total vehicles in and out were 162,023 and 156,285 respectively of which passenger automobiles were 126,970 in and 121,038 out. Pedestrians crossing Michigan Ave. bridge were 13,173 in and 12,279 out. In 1935 comparable figures were 12,823 in and 12,324 out.

Large Sewer on Ocean Bottom Has Joints of Novel Design

Concrete pipe with metal joints developed by Los Angeles County for mile-long outfall — Outer end 110 ft. deep — Pontoon placement method — Joint design facilitates handling by divers

AN OUTFALL SEWER of 5-ft. inside diameter now under construction by the Los Angeles County sanitation districts is using a type of joint and methods of placement developed expressly to avoid danger of trouble with joints in concrete pipe of large diameter without going to the expense of all-metal pipe. The design is believed to be proof against joint leakage and breakage such as has occurred in other ocean outfalls of large diameter where all-concrete pipe has been used. The use of pontoons for placing several sections at a time, the arrangement of details to facilitate submarine construction and the variation of joint design to suit depth and conditions on the bottom, indicate the extent to which study of the problems preceded the construction stage.

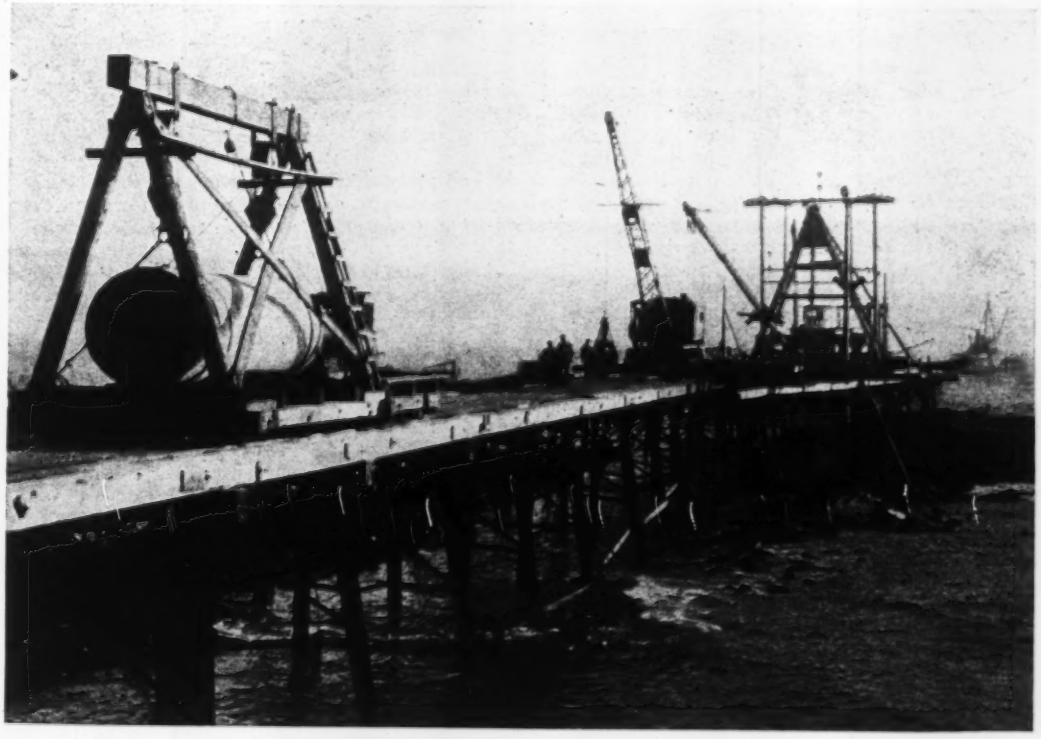
The outfall consummates plans which have been under consideration for more than a decade. Organization of the district and passage of the first bond issue in 1925 came about by reason of the fact that in the southwest part of Los Angeles County there are numerous communities, outside the Los Angeles city limits, which require some means of sewage disposal but lack access to the ocean or to flowing streams into which sewage could be discharged. Altogether some 225 sq.mi. of territory developing rather rapidly (both industrially and as residential districts) is included in this area needing means of sewage disposal. Nearly 50 separate communities or centers of population now are served by the trunk sewer system built by the Los Angeles County sanitation districts. The sewage so collected is being disposed of in a 12-m.g.d. activated sludge plant that was located not far from the inshore end of the outfall.

The construction program

In 1935, with the aid of PWA funds, contracts were awarded for 960 ft. of open cut conduit starting at the disposal plant, 31,115 ft. of semi-elliptical tunnel leading to the ocean shore and a 5,000-ft. ocean outfall. The conduit has been constructed, the tunnel has been driven and is being lined and the ocean outfall is under construction. The contractor has until July, 1937, to complete it to the full 5,000-ft. length.

Not only is construction made difficult by weather conditions but permanency of the outfall is dependent upon

FIG. 1—INSHORE OPERATIONS. At left car with an 18-ft. pipe section ready to be lowered to place. Excavation was carried on from the trestle and also from *A*-frame derrick barge in middle distance.



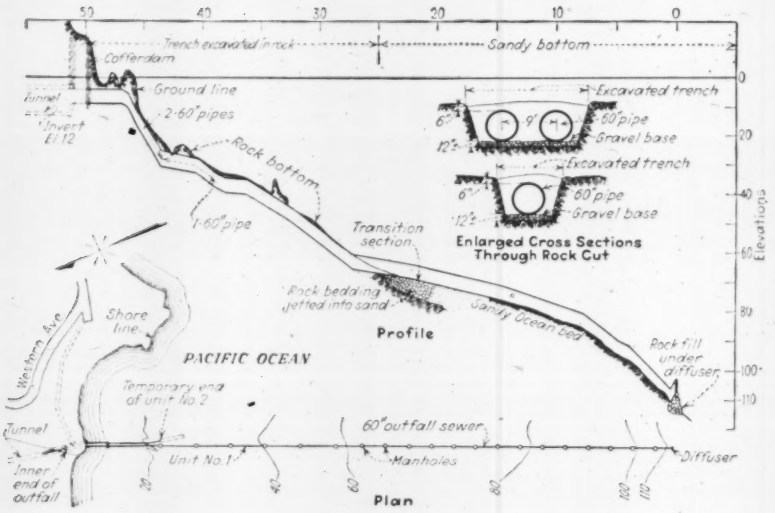


FIG. 2—PLAN AND PROFILE of Los Angeles County outfall sewer.

its ability to withstand shocks and strains that cannot be calculated exactly; for example, tidal currents, corrosive action of sea water, shifting ocean bottom, the grounding of a ship or a dragging anchor. To meet these conditions ruggedness is being "built in"; the design took account of the fact that on this job there would be no opportunity for accurate, careful work during construction nor for minute inspection afterward. On the contrary, work that has to be done in place, such as connecting up the joints, is done by submarine divers in semi-darkness on the ocean bottom where fingers instead of eyes are used to inspect and to judge accuracy of placement.

Recognizing the deficiency of joints in previously built ocean outfalls, on this project the joint problem was studied a long time in search of a design free from the disadvantages of earlier types. The result is an all-metal joint expected to give the advantages of an all-metal pipe line at the same time that it permits the shell of the pipe itself to be made of concrete. This is made possible by welding the reinforcing cage, such as ordinarily is used in concrete pipes, to the iron castings which constitute the joints. The essential in this design which has not been available in the large outfalls previously built, is the recent development of a cast iron to which steel bars can be welded. This feature will be described in more detail.

The first 2,000 ft. of the outfall at the inshore end is built of pipe sections 18 ft. long having joints of the Lock-Joint type but of a special design (Fig. 3-*A*). This much of the pipe is laid in a trench excavated in rock on the ocean bottom. Then comes a transition section 550 ft. long in which joints are of the ball-and-socket type and the pipe sections are only 12 ft. long. Finally, from the end of the transition section to the diffuser at the terminus of the outfall, the line consists of 18-ft. sections in which joints of the ball-and-socket and the Lock-Joint type alternate. Nearly all joints constructed under water are calked from the inside of the pipe, thus permitting the diver to work undisturbed by the wash of waves and with more freedom than in the cramped quarters to which he would be limited by an excavation made in rock beneath the pipe for a ball hole.

At the inshore end of the outfall it was practical to lay only one 18-ft. section of the pipe at a time. After each section was in place the final preparatory work for the next section was done in the trench. The fixed type of connection was used between these sections, first because the concrete backfill would hold them firmly in place in the trench and no joint articulation was necessary; second, because this type of joint, made up from the inside of the pipe, could be made quickest by the diver. On this job the simpler, inside-calked type of joint was made up under water by a diver in a little over four hours; calking one of the externally made-up ball-and-socket joints required from 40 to 48 hours of a diver's time.

The ultimate capacity of the outfall will require two pipes 5 ft. in diameter. The tunnel discharging into the outfall terminates in two 5 ft. pipes which extend into the ocean for a length of 667 ft. Here one of the lines is blanked off for future extension and a single 5-ft. line is continued as the present outfall.

The transition section, 550 ft. long, is a portion of the outfall supported on rockfill between the rock trench and the smooth sandy floor of the ocean bottom where the depth is 60 to 70 ft. From transition to the outer end (2,161 ft.) the pipe is laid, without cut or cover, on the natural bottom of the ocean. The bottom here is smooth and slopes gently downward toward deeper water. The gradient of the bottom is satisfactory for the outfall, the only grade stipulation here is that the forward end of each pipe section shall be at a lower level than the rear end. The outfall terminates in a three-way iron casting which will serve as a diffuser for discharging the sewage.

Solving the joint problem

Because of the years that elapsed between the early planning of this outfall and actual start of construction there was time to carry on a careful study of joint designs, making comparisons of those heretofore used and planning to strengthen the weak points. The result was not a single design but rather several, each adapted to conditions in some portions of the outfall.

Early in the study two governing conditions were agreed upon: (1) the proved advantages of a cast-iron joint

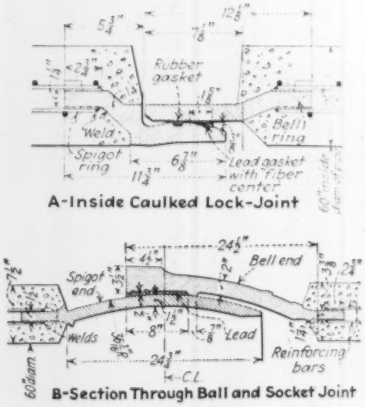


FIG. 3—TYPICAL JOINT SECTIONS: *A* is designed for quick assembly by diver, *B* gives the line flexibility and is made before placing pipe sections whenever possible.

gave preference to this type and (2) it was highly desirable that the pipe itself should be of reinforced concrete. There were two reasons for this latter requirement; first, concrete pipe could be made locally without the delays or freight charges incidental to bringing in large cast-iron pipe and, second, concrete pipe itself has given satisfactory service in ocean outfalls — only the joints have caused trouble. The search therefore was for a combination type in which pipe sections would have a concrete body and the joints would be of metal, preferably cast iron.

The major obstacle to such a pipe design was removed when a cast iron to which steel could be welded effectively came into commercial production. All connections between pipe sections of the outfall are made of this metal using castings made locally. Specifications for these castings provide that the metal used "shall be made by the cupola process and shall be graphitized with calcium silicide."

In the several types of joints, cast iron of this composition is welded to the longitudinal bars that constitute the reinforcing cage. The concrete shell of each pipe section has a thickness of 7½ in. and is cast so as to embed within it the reinforcing cage and parts of the two joint castings. Details of the joint in its several forms are shown in Fig. 3. The construction program was arranged to permit making up most of the ball-and-socket joints on shore because of the relatively longer time required to complete these under water. Joints to be made by diver, on the other hand, were designed to reduce to a minimum all operations to be completed under water.

In the joint designed for completion by diver (Fig. 3-*A*), there are two gaskets. The first, an annular rubber ring, is set in final position before the pipe section is lowered and the second, a lead gasket with a fiber center, goes into the water set temporarily at the extreme inner end of the bell of the pipe. It is held in this position during placement of the section by its stiffness and

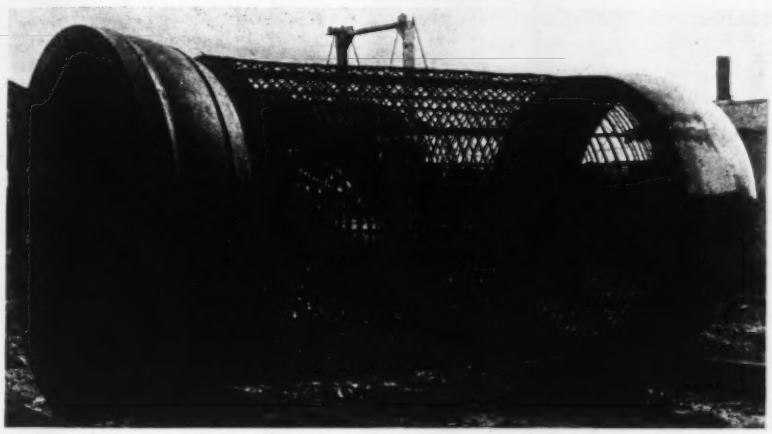


FIG. 4—WELDED ASSEMBLIES (above and right) of reinforcing cages and cast-iron joint rings before concrete shells of pipe are cast.

thus is conveniently at hand for calking. This final jointing operation, performed by the diver, consists in merely advancing this gasket into position and driving it into the annular space between spigot and bell. This is done from the inside of the pipe where the diver can work to good advantage. Every requirement of completing this joint can be met without necessity for visual inspection.

Joints of this simple type were used at the end of each 18-ft. pipe length in the inshore section where no flexibility was required. In the transition section the possibility of settlement made it desirable to use a ball-and-socket joint on each 12-ft. section. Fortunately this part of the line could be laid by the pontoon method which placed four 12-ft. sections at once. This permitted three-fourths of the ball-and-socket joints to be made on shore.

In portions of the line laid on the deep, sandy bottom, two 18-ft. sections are being placed at a time with the aid of pontoons. Fexibility is provided by using a ball-and-socket joint between the two sections that are connected up on shore. Thus a flexible joint with a 14-deg. articulation is put in the line at every second joint and the diver's work is limited to the (3-*A*) joint designed for quick under-water assembly.

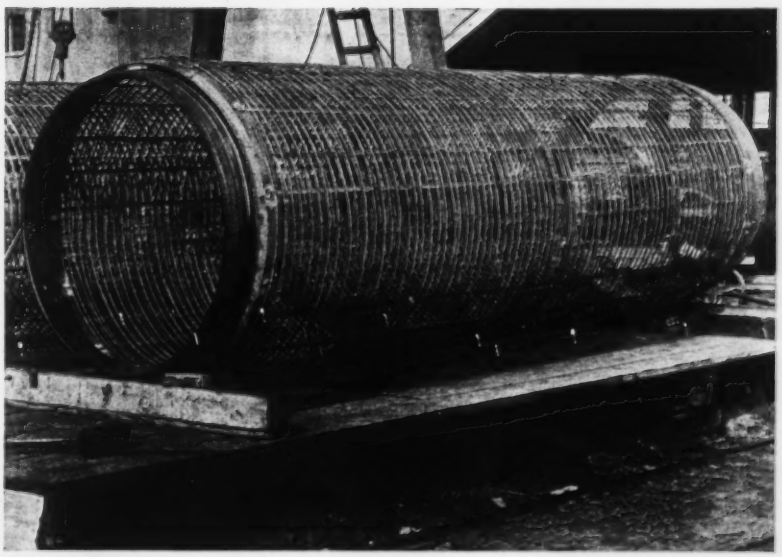
On the ball-and-socket joints, Fig. 3-*B*, specifications require spherical surfaces not to vary more than 0.01 in. from a true sphere; the sphere diameter may not vary more than 0.06 in. from the established dimension. The finish of the bearing seat has a diametrical tolerance of 0.015 in. and the joints are required to be interchangeable.

A serious difficulty with other outfalls which designers of this line determined to avoid, was lack of access to the inside. For the entire length, manholes are spaced 300 ft. apart. This feature, coupled with the fact that all of the fixed joints are constructed from the inside and all of the ball-and-socket joints may be repaired from the inside (until they have deflected the full 14 deg.) leaves only broken pipe or fully disconnected joints as sources of serious maintenance trouble. The manholes are iron castings welded to the reinforcing steel in the same manner used for attaching castings at the joints.

Placing inshore portions

The most difficult portion of the line, from the construction viewpoint, was the first 2,000 ft. on the inshore end. Here the maximum wave effect occurred in shallow water and the greatest risk was involved. On this portion of the work a 137-day period included 97 days on which rough seas prevented progress. The continual battering of the waves running in from the open sea interfered with every operation and storms frequently filled the submarine trench as soon as it had been excavated. The construction program was to blast out of rock formation a trench deep enough to entirely contain the pipe over which a concrete backfill then would be placed.

A trestle 509 ft. long was built at the shore end straddling the pipe trench. The trench was blasted out part of the way before the trestle was erected, but for a considerable portion of its length the trestle was built first and the trench was blasted out beneath it. Built to a convenient height above high water, the trestle served as a working platform from which to lower the 18-ft. pipe sections into place. It was necessary to use a trestle through the breakers and until a depth was reached at which the pipe-laying barge could function safely both as to draft and with less interruption from the surge of breakers. The method of excavation was by use of bombs as described in



detail in *ENR*, July 27, 1933, p. 93. Excavation, following the blasting, was done with a grab bucket operating first from a derrick on a trestle built over the trench and later from a derrick barge.

As fast as the trench was ready, pipe sections were lowered into place, first from the trestle and later from the derrick barge. After the sections were placed and the joints calked, concrete backfill was poured around them to a minimum thickness of 1 ft. on the sides and over the top of the pipe.

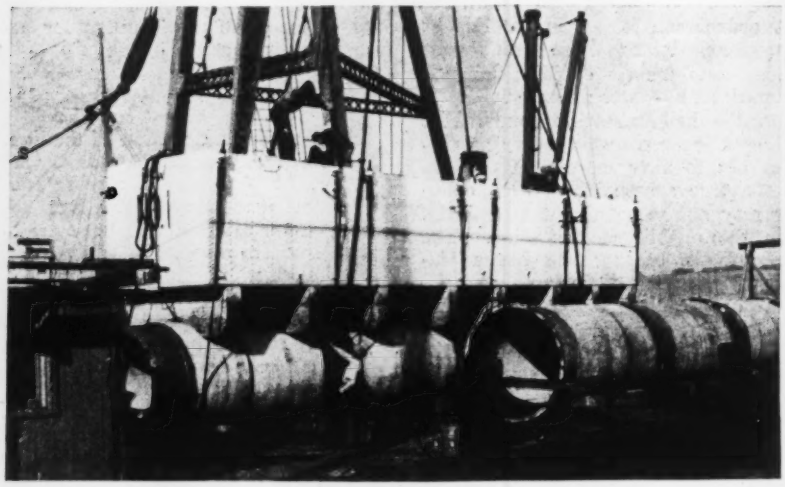
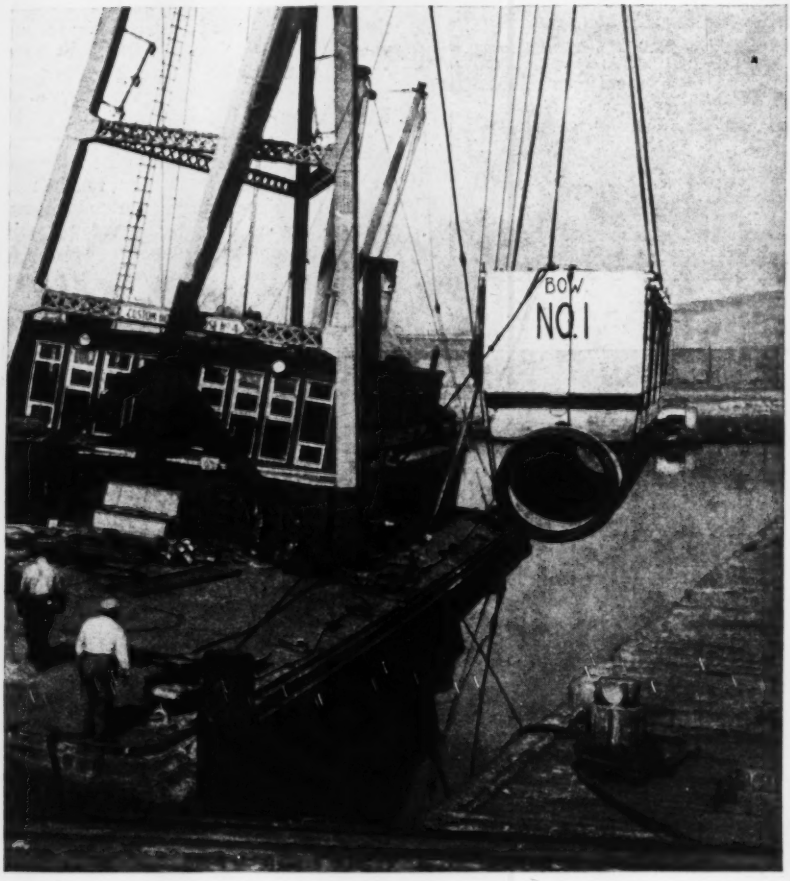


FIG. 5—ASSEMBLYING pipe sections on the launching barge. At the right four 12-ft sections are being jointed. At the left the pontoon has been rested on a four-section assembly around which slings are being passed.

FIG. 6—LAUNCHING THE PONTOON is done by the large derrick. This load with pontoon and four 12-ft. pipes weighs about 80 tons.



From the end of the trestle to the beginning of the transition section, 2,100 ft. from shore, placement of pipe was by derrick barge. From that point to the end of the outfall, 5,000 ft. from shore, placement is with the aid of pontoons.

Practice in the casting yard where the pipe sections are manufactured is not very different from that ordinarily used in making large concrete pipe. The steel reinforcing is assembled in a cage in the usual manner with the ends of the longitudinal steel, which are 1x1¼-in. straps, welded to the flanges of the special cast-iron joint rings. The pipe walls, with a thickness of 7½ in., are made of 1:1½:2½ concrete in which specifications require a 28-day strength such that a load of 7,000 lb. per lin.ft. on the pipe shall not cause any cracks exceeding 0.01 in. in width.

Pipe sections are delivered on low trailers to the launching barges at Los Angeles harbor, about 8 miles from the outfall.

Pontoon operations

The pontoon operations begin with the aid of a large derrick barge. The barge deck area is 80x180 ft. and it has a boom that can lift and launch the 80-ton loads consisting of pontoon and pipe section assembly. In preparation for launching, the pipe sections are placed in cradles on a 45x100-ft. pipe assembly barge and here the sections are jointed up, two or four at a time, as required. When the assembly is ready for launching, timber yokes are put on top and a steel pontoon is picked up by the large derrick barge alongside and placed on top of the timber yokes. After pipes and pontoon are fastened together with cables, the derrick bodily lifts the assembly, swings it over side and lowers it into the water. The assembly then is towed to the outfall by a tug.

The large derrick barge and the assembly barge are moored side by side in the harbor. Two pontoons are used, thus making it possible to work on one pipe assembly while another is in process of being placed. These same pontoons were used in placing the Hyperion outfall sewer built in 1925 (*ENR*, Aug. 20, 1925, p. 292).

Each pontoon is 46 ft. long, 8 ft. wide and 6 ft. deep; the lifting capacity is just about equal to the 50-ton weight of four 12-ft. sections. Air lines are connected to 1¼-in. pipe nipples in the top of the pontoon; one such connection is provided in each of the five compartments into which the steel tank is divided. Water can flow in or out, governed by the air pressure, through an opening on the side near the bottom of each compartment.

The pipe assembly is held against the bottom of the pontoon (with heavy timber yokes between) by cable slings, two for each section. These cables are at-

tached at the top of the pontoon on one side, pass thence around the underside of the pipe section and up the opposite side of the pontoon. Each cable terminates in a "pelican hook" which has a toggle trip designed for quick and easy release with the minimum of time and effort by a diver but is not likely to be loosened accidentally. Alternate cable slings have pelican hooks on opposite sides of the pontoon to avoid any tendency to rotation when the assembly is lifted for launching. Thus the eight slings that attach four pipe sections to a pontoon have four pelican hooks on each side of the assembly. In releasing the pipe on the ocean bottom divers work in pairs, one on either side of the pontoon. Each diver releases four hooks before the pontoon is lifted off the pipe.

After the pontoons and their attached pipe sections arrive over the outfall, water is allowed to enter the compartments and the assembly settles gradually. Accurate control of the buoyancy is maintained by the use of compressed air lines which remain connected to the five separate compartments as the pontoon goes down. If the pipe placement on the bottom is not satisfactory on first trial, the water in the pontoons can be forced out by admitting more compressed air, thus lifting the pipe assembly and enabling it to be placed again. In order to avoid the loss of control that might result from too sudden a change in pontoon buoyancy, the program is to use only so much air pressure as will give the assembly a slight negative buoyancy. Thus the actual lowering and placement is done with the aid of a derrick barge. The use of compressed air simply decreases the loads to be handled.

The work is being done by the Los Angeles County Sanitation Districts, A. K. Warren, chief engineer and general manager, A. M. Rawn, assistant chief engineer in charge of construction and operation. F. D. Bowlus is resident engineer on the construction project. The Meehanite iron castings for the joints are made by the Kinney Iron Works, Los Angeles, the concrete pipe sections are manufactured by the American Concrete & Steel Pipe Co. and contract for construction of the 5,000 ft. of outfall (awarded Aug. 7, 1935) is held by the Merritt-Chapman & Scott Corp., for which L. Curtis is West Coast vice-president and manager, and R. Helen is job superintendent.

New Sheetpile Cutting Record Set for Underwater Work

Underwater cutting of steel sheetpiling in the caissons for the Marine Parkway Bridge at New York establishes a new record for speed and economy—Diver working in 30 ft. of water cut 2,000 piles

By Edward Ellsberg and Charles Kandel

Consulting Engineer and General Manager, Craftsweld Equipment Corp., New York, N. Y.

NEW RECORDS for underwater cutting of steelpiles were established early this year in cutting off the upper part of 2,000 piles used for cofferdams for piers of the Marine Parkway Bridge now under construction across Jamaica Bay Inlet, Long Island, New York.

The bridge is to have a steel superstructure supported on fourteen concrete piers founded on wooden piles deep in the sand underlying the inlet. Because of the exposed location, in which the outlying sand spit provides little protection against ocean gales, and because currents at each change of tide reach an average rate of 6 miles per hour, it was decided to use special precautions to protect the pier footings against scour. To this end, the bridge design specified that interlocking steel sheetpiles be used for the cofferdams, that the cofferdams be used as outside forms for the footings, and that the sheetpiles be cut off above the footings, leaving the lower part in place as permanent protection to the footings.

The tops of the footings, generally, are 32 ft. below low water and the piles were required to be cut off at a depth of about 30 ft. In most instances, there was a clearance of from 6 to 8 ft. between the sheetpiles above the footing level and the face of the piers, thus making it possible to do most of the cutting work from the inside of the cofferdams where the diver would be protected against wave action and tidal currents.

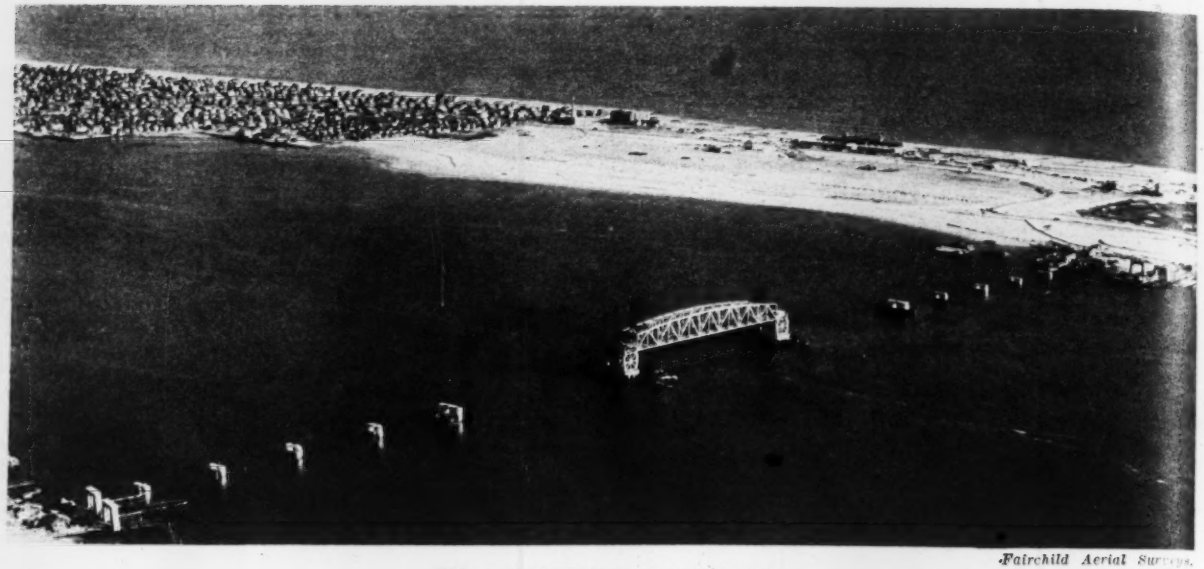
Cutting operations

Forms had been stripped from the piers and the cofferdams had been flooded before the cutting work was begun. The cutting was carried on from a barge, using the equipment shown in one of the accompanying illustrations. When working inside a cofferdam, the diver used a small but very substantial float consisting of a timber platform mounted on oil drums that supported the ladder by which he descended.

The conditions under which the work was to be done were unusually severe. Among other things, they entailed the following: (1) Cutting was to begin on Nov. 1, 1936, and had to be completed before Jan. 15, 1937. Deducting Saturdays, Sundays, and holidays from this total of 76 calendar days left a net of 49 working days, thus setting a schedule of over 40 sheets to be cut per day. (2) The fourteen cofferdams had been sunk at the time the cutting contract was entered into and would be ready for cutting as fast as the concrete could be placed and the piers sufficiently cured for stripping. (3) The time of year made it highly probable that there would be at least ten days during which diving work could not be carried on profitably.

In view of these conditions, it was decided to estimate the effective working period at 36 days, thus increasing the proposed schedule to 55 sheets per day. A review of previous records of performances on this class of work showed a maximum of 30 sheets cut per day and an average of less than 20 per day. This pointed to an organization entailing three crews, one for each of three shifts for the entire period. This would have been a costly set-up as the men would have had to be maintained on a weekly basis although work would be available for them on an average of only three days per week.

Study of the problem was then shifted



Fairchild Aerial Surveys.

FIG. 1—MARINE PARKWAY BRIDGE across Rockaway Inlet, New York. The bridge piers were built in sheetpile cofferdams that were cut off 30 ft. below water level after the concrete had been placed. The left span over the shipping channel is shown in place.

to determine the possibility of redesigning the equipment heretofore used on similar cutting work to increase the rate of cutting, thus making it possible to eliminate non-productive time and yet bring the day's output up to that required to meet the specifications with one crew. This study resulted in a redesign of the Ellsberg underwater cutting torch and improvements in the accessories provided with it.

Using the new torch, a single crew was put on the job equipped with every known facility for reducing non-productive time. The first week of cutting showed an average of 31 sheets per day, the next two weeks an average of 50 per day, and thereafter *an average of 60 sheets cut per day of operation with one crew working in a single shift.* The actual cutting time per day was about three hours, or an average of 20 sheets per hour. The maximum speed attained was over 30 sheets per hour. When working under especially favorable conditions the maximum daily output far exceeded the average. The entire job was completed in 40 working days with a total of 2,118 steel sheetpiles cut.

The cut sheets were pulled and removed with ease, the maximum estimated pull being not over 10 tons, and the average under 5 tons, with ample facilities for bending and breaking when required. Not a single sheet required recutting or even offered any special difficulty in pulling. The pulling proceeded steadily with an average of 60 sheets per 8-hour shift.

Favorable conditions

The conditions under which a diver has to work are of utmost importance to the speed of underwater operations of this character. On the Marine Parkway Bridge work credit for the record obtained is due in large part to the following conditions that made it possible to develop the full efficiency of the cutting torch: (1) Visibility below water was exceptionally good. (2) The diver was standing on a firm footing and was able to move with ease from sheet to sheet as he advanced the cut. (3) The interlocks were clean and no foreign material interfered with the action of the flame upon the steel. Clean cinders had been used in the locks and presented no handicap in cutting. (4) The steel sheets had been submerged only about four to five months and were relatively free from rust or marine growth. (5) The diver found it possible to carry on his work in such a way that he suffered a minimum of interference from strong tides prevailing around the bridge. (6) Sufficient spare equipment was provided to reduce delays that might otherwise result even from minor imperfections in equipment. (7) The surface personnel was unusually skilled and cooperative, responding promptly to the diver's demands and frequently anticipating his needs. (8) The supply of oxygen and hydrogen was ample and always available. (9) The compressed air for diver's use and for operation of the underwater torch was clean and adequate in every way, enabling the diver to work in comfort, operate the torch with maximum speed and utmost confidence. (10) The diving gear furnished with the equipment had been carefully overhauled and ample spares provided for immediate replacement, so that at no

FACTORS AFFECTING THE SPEED OF UNDERWATER PILE CUTTING

Factors	Favorable	Unfavorable
1. Depth at level of cutting	Less than 35 ft	Over 40 ft.* — Over 100 ft.‡
2. Diver's footing	Firm and level	Soft† — Uneven*
3. Distance from diver's footing to level of cutting	Over 36 in	24 in.* — Less than 18 in.†
4. Position of diver at work	Erect — on one knee	Crouching* — Prone‡
5. Access to work	Straight descent	Obstructed* — Hazardous†
6. Working space for diver	Clear — ample	Cramped — Obstructed*
7. Weather conditions	Moderate — calm	Windy* — Cold†
8. Speed of tide or current	Less than 1 m.p.h	Over 1 m.p.h.* — No protection‡
9. Visibility below water	Good — clear	Poor* — Muddy water†
10. Clearance on far side of sheeting	Unlimited — not less than 6 ft	Less than 2 in.* — None‡
11. Total sheets to be cut at one time	Over 1,000	Less than 250† — Less than 100‡
12. Thickness of sheeting	318 in	Over ½ in.†
13. Type of sheeting lock	Small — close	Large* — Open†
14. Type of sheeting	Single thickness throughout	Fabricated* — Two or more ply‡
15. Filler used in locks	Clean cinders	Cement grout‡
16. Surface personnel: tender and helper	Experienced and capable	Inexperienced† — Careless‡
17. Source of compressed air for diver	Dependable compressor and ample reservoir recently cleaned	Hand pump — Compressor delivering rancid air‡
18. Diving facilities	Low float or scow — ample area	High deck — No stage†
19. Stability of sheeting	Firm — upright	Tilted* — Loose* — Wobbly† — Twisted‡
20. Pulling equipment		
Maximum lift	Over 15 tons	Under 5 tons†
Booming arrangement	Ample swing, wide angle	None‡ — Straight pull†
21. Progress of work	Continuous	Interrupted†
22. Period of work	Normal — daylight	Extended* — After sundown*

* Combination of these factors may reduce cutting speed 10–25 per cent.
† Combination of these factors may reduce cutting speed 30–50 per cent.
‡ Combination of these factors may reduce cutting speed 60–75 per cent.

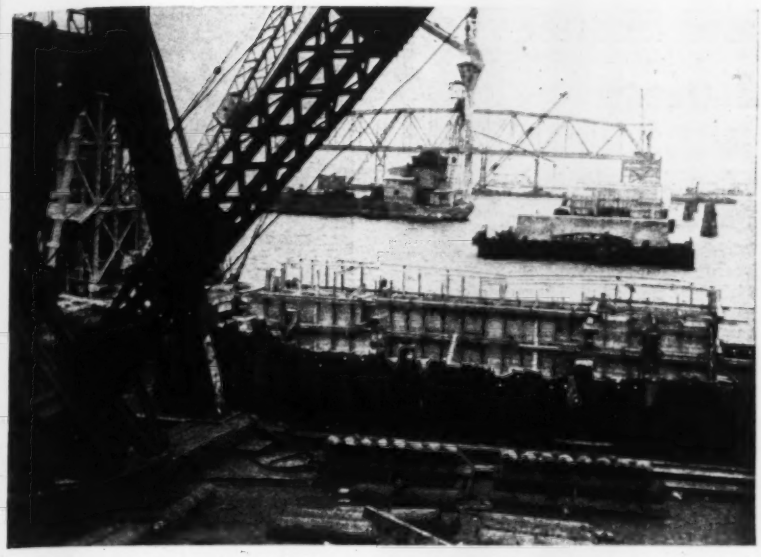


FIG. 2—**WORKING BARGE** lying alongside one of the piers. Beyond is a completed pier ready to have the top of the cofferdam removed.

FIG. 3—**UNDERWATER CUTTING OUTFIT** as set up on the working barge. An ample supply of gas was kept available to the diver at all times as the gas supply is an important factor in the speed of work.

time was the diver required to descend with defective gear.

Conditions controlling costs

It is important to note that the performance on this job could be duplicated on a major job under similar conditions, but under less favorable conditions the daily output would be materially reduced because of changing factors that might not appear to the inexperienced as being particularly adverse. In the accompanying table an attempt has been made to demonstrate how changes in conditions under which the work is carried out affect the cutting speed. Although some of the factors listed might be considered elementary in construction operations above water, they may become controlling elements in diving operations.

The costs on this work were extremely low, averaging about 50 per cent below any known previous record when computed on the same basis. The items entering into the costs were as follows: rental of underwater cutting equipment; wages of diver, tender and helper; workmen's compensation insurance for three men; oxygen and hydrogen consumed. The total amounted to less than $6 per sheet, which is believed to be an all-time low record for this class of work.

The cutting was done by diver John R. Kelley, who was awarded the Navy Cross for his work in the raising of the U. S. Submarine S-51 in 1926. (*ENR*, Aug. 5, 1926, p. 210.)

The bridge is being erected by the Marine Parkway Authority. The Frederick Snare Corp. built the foundations, and the underwater cutting torch and accessories used in the work described herein were supplied by the Craftsweld Equipment Corp., New York, as subcontractor.

Tax Assessing Urged as County Function

IMPROVED tax assessment by putting the assessment function on a county, instead of a township, basis is promised in several states in the near future, if recommendations made by special study commissions to the legislatures are carried out, according to Albert W. Noonan, technical director of the National Association of Assessing Officers.

In his annual resumé of changes in assessment procedure Mr. Noonan reports that, although the number of states that assess on the county plan still remains at 24, there is definite interest in changing over to the more extensive unit.

Recommendations of the Minnesota and North Dakota study commissions to their 1937 legislatures would replace, in the two states, a total of 4600 assessors with 138, if township assessing offices were abolished. The New York Commission for the Revision of the Tax Laws recommended a like change for that state in 1937, advising creation of county boards of review and the elimination of town and village assessors.

Objections to the extremely localized assessor system, according to Mr. Noonan, center around the general recognition that it produces great and sometimes flagrant inequalities of assessment, both among individuals within a district and also among districts. Although most assessors are conscientious, their brief period in office and their lack of experience and training are likely to cause haphazard appraisals. Inefficient assessment of property, in turn, says Mr. Noonan, results in lessened support and lack of confidence in the property tax.

Habit, prejudice and established political tie-ups of local officials are the chief reasons why no more than half the states have changed the plan of property assessment that was found more suitable in the early days than it is now, Mr. Noonan says. He points out that most of the states still using the township basis of assessment are in New England and the East. In the South and West, the county plan is the rule.

Reducing Head Loss and Slam In Check Valve Installations

Ingenious device consisting of a spring and solenoid-tripping mechanism attached to ordinary check valve eliminates surge when closing and minimizes loss of head when open.

By George A. Shipe,
Water Department Engineer, Santa Ana, Calif.

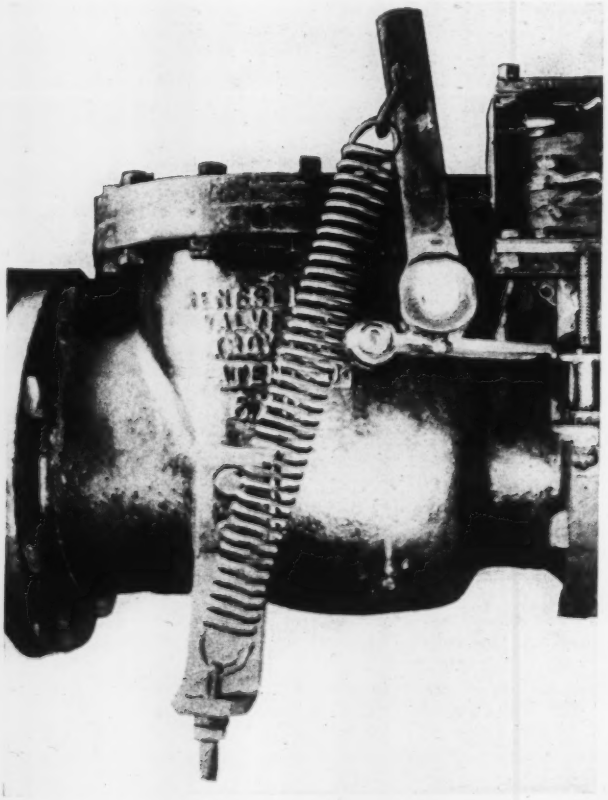
THE CHECK VALVE, generally considered a minor piece of equipment in a water works system, plays an important part in determining operating efficiency and economy. This is especially marked when pumping water at any appreciable pressure where loss of head and surge effects must be considered. Investigations carried out by the writer provided a measure of head losses through a valve and led to the development of a simple device for reducing head loss and for eliminating slam when the valve closes.

An example of the head loss that occurs is given by the results of a test on a 6-in. weight and lever type of check valve connected to a pump delivering 1,000 g.p.m. at a velocity of 11.33 ft. per sec. Mercury column measuring tubes were connected to the pipe line on each side of the check valve as shown in Fig. 2. The loss of head registered 3.75 in. of mercury or 4.24 ft. of water; note, however, that the weight and lever of the valve shown in the illustration were raised in wide open position which seldom occurs under normal conditions of operation. A second test, with the mechanism weighted for regular operation, showed that at this opening the valve built up a loss of 6.25 in. of mercury, corresponding to 7.08 ft. head loss of water.

Using this latter figure for estimating increased pumping costs, based on pump efficiency of 75 per cent and power at $.01 per kilowatt hour, it was found that friction of the valve accounted for an additional expense of $13.38 per month.

FIG. 2—MERCURY COLUMN reading on both sides of the 6-in. check valve showed friction losses up to 7 ft. of head.

FIG. 1—QUICK CLOSING CHECK VALVE device to minimize slam and loss of head. The spring, attached to the disk lever of the valve, is tripped by a solenoid mechanism attached to the pump motor circuit.



Where check valves are installed on lines that are subject to quick stoppage of flow, particularly in the case of electrically driven pump systems, the violent surge created by the valve disk when it closes may cause serious damage to the pipe line. The same condition occurs when the line is on a steep slope or where air chambers are installed along a pump discharge line on a flat hydraulic gradient.

A typical condition of steep gradient or slope occurs where a large and small pump, operating side by side, are discharged into a common header. When the small pump is shut down the pressure on the discharge of this pump falls off immediately. The pressure in the header, however, is maintained by the large unit with the result that the almost instantaneous reversal of flow in the small check valve slams the valve disk to its seat, unless positive means are provided to force the disk closed at the very instant the small pump stops operation. To mitigate the unbalanced pressure condition it has been found necessary to load the check valve disk lever with both weights and springs, but this in turn produces high head losses because the disk is always held close to its seat.

Quick-closing device

With the idea of positively eliminating slams and reducing head loss through the valve to a minimum (and incidentally minimizing the wear on moving parts) a quick-closing check valve was developed. It consists simply of a spring attachment on the disk lever of the valve which is held in an open position by a latch cam that is operated by a combination holding and releasing solenoid (Fig. 1). The solenoid is connected with the pump motor electric circuit. On shutting down the pump, or in case of power failure the solenoid immediately becomes deenergized; this permits the core of the solenoid to strike a latch which releases the valve disk so that it can be carried quickly and quietly to its seat by the spring on the lever arm.

Slam is positively eliminated because the spring arrangement can be timed to close the disk at the instant the column of water comes to rest. The device also permits adjustment of the valve opening lever so that when the

mechanism is in operation the disk is lifted and held out of the stream flow entirely; this is a big factor in head loss reduction.

The device attached to the 6-in. check valve, shown in Fig. 1, has been in operation for more than eighteen months and it has given reliable service. The head loss has never exceeded 1 ft. although the velocity of flow reaches 12 ft. per second. The saving in pumping cost, without considering the value of the safety features it incorporates, has repaid many times over the small investment required for the installation of this device.

Failure of Moving Scaffold on Golden Gate Bridge Reviewed

Fall of platform, with ten fatalities as workers stripped roadway forms, may have had initial cause in failure to use safety bolt although several other causes are possible — New safety net being installed

INVESTIGATIONS, at least five of them, are under way to determine if possible the cause of the accident on the Golden Gate Bridge at San Francisco, Feb. 17, when ten workmen lost their lives and three more escaped almost miraculously. Meantime, information is presented in the following to give a general idea of equipment used, methods employed and conditions believed to have obtained at the time. News reports have been published in last week's issue, p. 349 and in the Feb. 25 issue p. 313.

Essentials of the accident are that hangers by which a scaffold was suspended from the under side of the floor system near the center of the 4,200-ft. span somehow dropped one end of the scaffold on which a crew was stripping forms from the under side of the west 20-ft. strip of roadway paving. Thus tilted, the scaffold slipped from the two remaining hangers (four were in use at the time), fell into the safety net just below, tore the net from its support and plunged on down more than 200 ft. to the waters of the Golden Gate. A six-knot tide in water more than 300 ft. deep swept scaffold and net away with such speed and force that 2,100 ft. of the net, extending from mid-span all the way to the San Francisco tower was ripped loose from its support. Of the men on the scaffold at the time one managed to cling to a floorbeam until rescued, twelve went down with the scaffold and net; of these only two were taken out alive. Two days later the net was raised and with it one body was recovered.

There were two duplicate scaffolds, one for each of the outer 20-ft. strips which now have been paved all the way across the bridge. The second scaffold is not being used pending replacement of the safety net and such new scaffold design or safeguards as may be decided upon. Meantime, paving of the center 20-ft. strip of the 60-ft. roadway can be carried on.

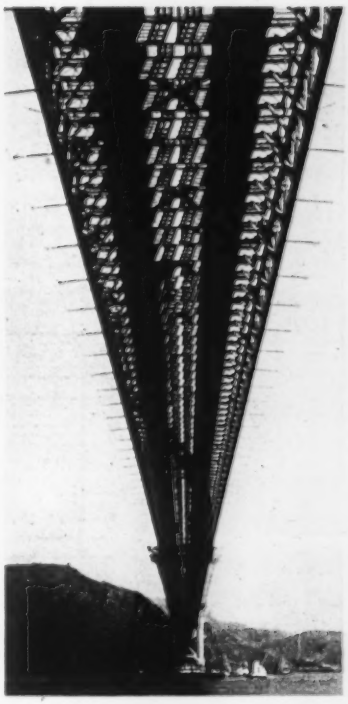
Scaffold design

The scaffolds were built according to designs of the contractor. They were completed and delivered to the bridge on Feb. 15. On the day following they were operated experimentally to make sure that they functioned satisfactorily. On Feb. 17, the day of the accident, they began work on regular schedule with a full complement of men.

The scaffold that fell was working under the west or ocean side of the bridge. It consisted essentially of a sliding platform, main members of which were two longitudinal 16-in. x 36-lb. wide-flanged beams 60 ft. long spaced 23 ft. 8 in. They carried the floor on which the workmen stood and were supported by hangers fastened to the bottom flanges of the cross girders of the floor system. The total weight of the scaffold was about 10 tons. The details of the scaffold are given on a drawing on the next page.

An essential feature of the scaffold was a pair of "tables" 10 ft. 10 in. x 21 ft. 8 in. in plan, capable of being raised 8 ft. by hand winches, thus providing a working platform under the floor system at whatever height would be convenient to the workmen. Two tables were used instead of a single large table to minimize the load on the hoisting mechanism, which was operated by hand. These tables were decked over with 5-in. I-beams, 2x4-in. wooden joists and a flooring consisting of 1-in. boards.

The tables were built exactly in the center of the scaffold floor. When in working position the scaffold was held by a four-point suspension, that is, by a hanger from the flange above at each corner of the bay in which stripping operations were under way. As the cross-girders of the floor system are 25 ft. apart and the paved strip is 20 ft. wide, the bays in which work is carried on are approximately 20x25 ft.

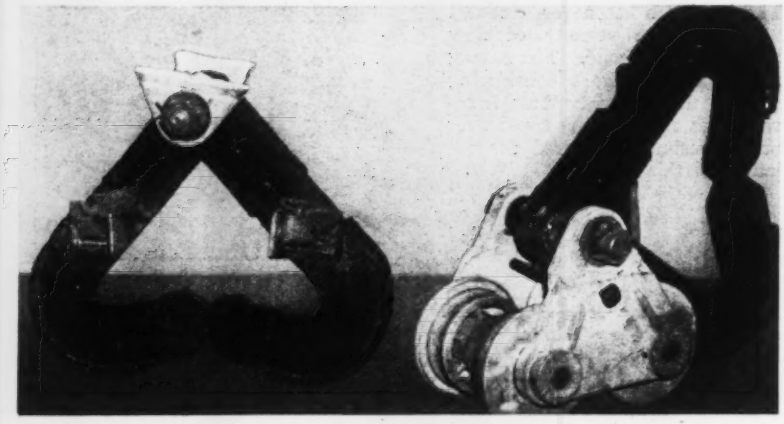


UNDERSIDE of the 4,200-ft. main span from the San Francisco pier showing the two 20-ft. strips of floor paving. The center 20-ft. of roadway is open as are the 15-ft. sidewalk spaces on either side. Note outrigger supports for cable from which safety net ripped away under the weight of the scaffold.

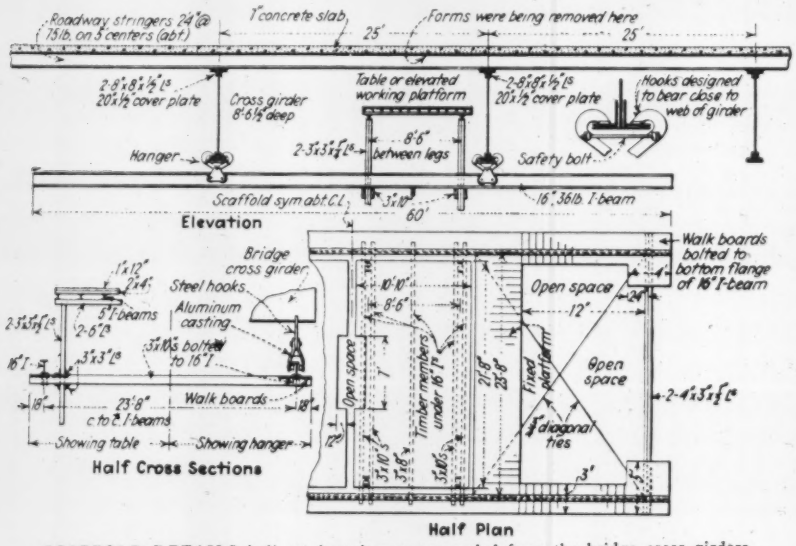
In addition to the four hangers required for support, an additional pair was provided for use when the platform was advanced from one bay to the next. This additional pair of hangers was not attached to the floor girders at the time of the accident. Two hand winches were provided as an advancing mechanism. By means of cables attached at convenient points ahead and behind, the scaffold was eased ahead, the longitudinal beams rolling on flanged cast aluminum wheels in the hangers.

Scaffold operation

When the advancing beams, cantilevering from the four-point suspension, reached a point beneath the next floor girder, the two extra hangers were brought ahead and attached to this forward cross-girder. The beams then were entered upon the rollers and the scaffold advanced, with its weight at the forward end carried by the newly placed supports. Entering the beams



HANGER UNITS that supported the working platform. Note angles welded to hooks for safety bolts; cast aluminum side members also have a tie bolt to prevent spreading. The hanger with the broken aluminum castings is shown at the left.



SCAFFOLD DETAILS indicate how it was suspended from the bridge cross girders. The elevating tables provided a working platform for the men removing the floor slab forms.

into the hangers was facilitated by a slightly chamfered forward end of the beam flange. The weight of the cantilevered portion of the scaffold made it necessary to raise it about 2 in. to fit into the newly placed hanger supports.

When the advancing scaffold, thus supported by six hangers, advanced far enough to withdraw the beams from the pair of hangers at the rear, movement was stopped and the two rear hangers were taken off and laid on the platform until again needed. The scaffold was moved forward until the elevating tables were centered beneath a new bay. Here it was stopped, the hand winches were used to raise the tables within the area enclosed by the cross-girders and stripping operations began. As forms were stripped everything taken off was passed up through the center lane (as yet unpaved) to the deck of the bridge. When stripping operations were completed the tables were lowered so that they could pass beneath the cross-girders, and the scaffold was ready for another move. The floor girders between which the tables were raised have a depth of 8 ft. 6 in.

Hanger design

Each hanger consisted of two parts, a pair of steel hooks or tongs to be attached to the bottom flange of the cross girder and a cast aluminum detail made up of side plates and four wheels on which the scaffold beams ran. The wheels had flanges on the side next to the plate to keep the beam centered; the tread of the wheels was shaped to fit the taper of the beam flange. Aluminum was used for this detail to minimize weight since the hangers had to be removed, carried forward and put into place entirely by hand. Even using aluminum castings the weight of each unit was about 150 lb. It was a two-man job to remove them and to set them up.

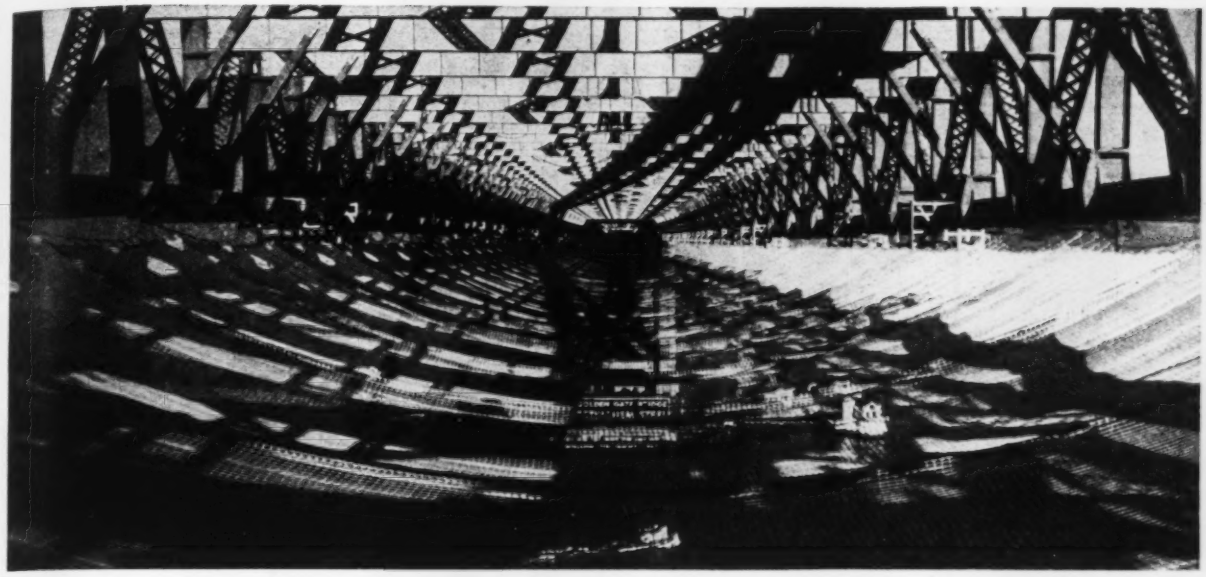
The tips of the tongs or hooks had a slight downward projection to insure bearing on the inner portion of the cross-girder flange next to the web. The flanges consist of a pair of 8x8-in. angles and a 20x½-in. cover plate with rivets staggered on 6-in. centers. When the hooks were in place a safety bolt was put in, threaded through holes in clip angles welded to the sides of the tongs. The safety bolts were $\frac{5}{8}$ in. in diameter and once they were in place it is believed the hooks could not possibly open and slip from the flange.

The cast aluminum side members were thickest at the top where a $1\frac{5}{8}$-in. bolt connected them to the hooks, and thinnest at the bottom edge. However, the bottom edge was thickened by bosses where bearings for the wheels were put in. Also, there was a pair of fins or ribs on the outside of each casting converging upward on the triangular side members. These fins discontinued on a line about even with the top of the wheels and at this point a $\frac{3}{4}$-in. tie bolt was put through both plates to prevent their separation.

Another feature of these side members was a bend or offset just above the wheel tops. This apparently was used to bring the bearing in the supporting bolt at the top immediately over the line of loading on the wheel tread. In the broken casting found still attached to its girder after the accident and also in a hanger unit that was tested in the University of California laboratory, the breaks in the aluminum sides occurred along a horizontal line above the wheels where the tie bolt passes through. In the laboratory test the hanger failed under a total static load of 20,900 lb. Every endeavor was made in this test to simulate loading conditions in service, but without impact or torque.

Cause ascribed to hangers

The accident occurred while the scaffold was in process of being moved forward and just after it had left the pair of hangers at the rear. Thus the forward end was being supported upon a pair of hangers just put in place. Of these two hangers one was missing after the accident and the other was found broken with the hooks and the upper portion of the aluminum plates remaining attached to the bottom flange of the floor girder. The fact that the hanger opposite the one broken was missing after the accident lends support to the theory that by some means the hooks of the missing hanger got off the bottom flange. Since it is generally agreed that the hooks could not come off if the safety bolt were in place, one of the theories advanced is that in the absence of the safety bolt the advancing movement of the scaffold somehow caused the hooks to let go and come off. If one hanger let go, dropping a corner of the platform, the impact and torque on the opposite hanger might



PART OF SAFETY NET that was not torn away. The net had saved the lives of 11 workmen before a load too heavy for its edge supports tore it away. Marin tower in background.

break the aluminum castings just as they were found to have been broken. With two hangers at one end of the moving platform thus releasing their load it would be inevitable that the platform would go on down. Apparently, the scaffold beams ran on through the two rear hangers which were found still on the flange after the accident.

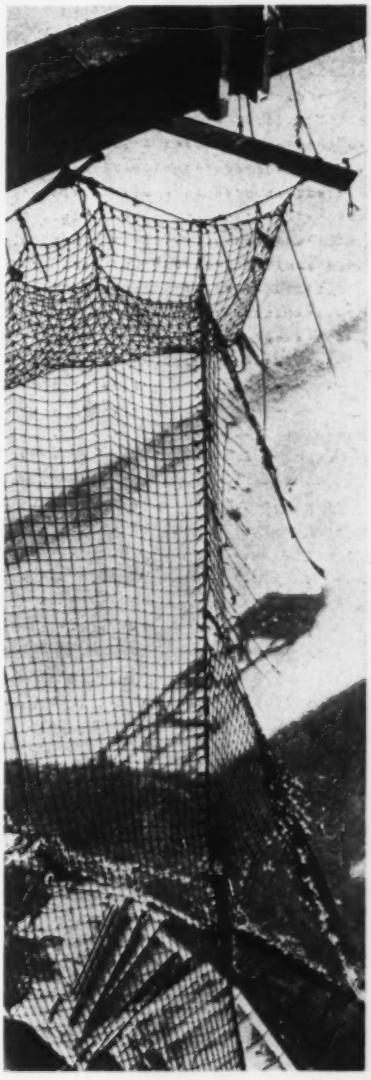
In the study of causes the question as to presence or absence of the safety bolts whose function was to prevent the hangers from slipping off the girder flange is considered to be very important. Careful inquiry was made by a representative of *Engineering News-Record* as to whether these safety bolts were in the hangers found remaining on the bridge after the scaffold fell. Of the three hangers that stayed on the bridge the one that was broken through the aluminum casting still had the safety bolt properly in place on the hooks. Of the pair of hangers at the other end of the scaffold one had no safety bolt and was hanging from the flange by one of its hooks; the other hook had swung away from the supporting flange. The opposite or third remaining hanger still had both hooks in place on the flange. However, in the case of this third hanger the safety bolt with the nut threaded in place was hanging in *one* of the angles welded on to carry the safety bolts. The presence of the nut would indicate that at the time of the accident this bolt had not been passed through the second angle and hence had not been placed where it could fulfill its safety function.

The safety net

The safety net is made of ½-in. hemp rope with 6x6-in. mesh; metal clamps hold the ropes together at intersections. The net was built up in 50x120-ft. units, the 120-ft. dimension placed transverse to the bridge centerline, thus allowing the net to extend about 10 ft. beyond the bridge sides. Steel brackets were used to support a cable 10 ft. out from the stiffening trusses to which the safety net was attached. Along the edge of the safety net a 1-in. hemp rope served as a border for the net proper, and at intervals of about 5 ft. this border rope was attached to the longitudinal steel cable by hemp tie ropes.

When the scaffold fell into the net the impact tore the net free from the bridge at the weakest points, namely, by breaking the tie lines between the 1-in. rope border and the steel cable. After the scaffold enmeshed in the net reached the water the pull resultant from tidal currents was sufficient to continue to break away the supporting tie lines, and the entire 2,100-ft. length of net to the San Francisco pier was ripped off and fell into the water.

Official investigations as to the cause of the accident are being made by the Golden Gate Bridge & Highway District, the grand jury, the coroner's jury, the state industrial accident commission and the Pacific Bridge Co. Contract for the paving operation is held by Barrett & Hilp and the Pacific Bridge Co. jointly. The latter company is carrying on the form stripping operations. The Pacific Bridge Co., organized in 1868, is well known throughout the West Coast where it has completed successfully many important construction jobs with a good safety record.



NET REMNANT hanging from tower at south pier.

Rehabilitation of the Ohio Valley

Flood-stricken communities are coming back in amazingly quick time as debris is cleared away, damaged property is repaired and essential services are restored—Paducah, Louisville and Portsmouth suffered greatest loss

By H. W. Richardson
Associate Editor, Engineering News-Record

IN THE PAST FEW ISSUES Engineering News-Record *has presented the news of the recent record floods in the Ohio valley obtained by a staff editor on a trip during the high water stages. To complete the coverage of the floods and to give our readers a picture of the damage wrought, the manner and the speed of restoration of the stricken cities and towns, this same editor traveled through the flooded territory three to four weeks after his previous trip. Conditions as he found them are depicted in the following report. It presents the general situation throughout the valley and details the recovery in Louisville, Paducah and Portsmouth.*

—EDITOR.

THE SPEED of recovery of the Ohio River valley from its devastating flood is amazing. In fact, to one who saw the river in full flood surging into scores of cities and towns to engulf them to record heights, a few short weeks ago, the transition from utter desolation to near normalcy is almost beyond belief. The cheering sound of hammers and saws has replaced the cries of people trapped in second stories and on roofs waiting to be rescued; debris-laden trucks and those loaded with plaster, cement and lumber rumble down streets which only a short time ago were the course of mercy-bound boats. Retail business is being conducted from packing-case counters within bare-walled stores while plasterers work overhead and new fixtures are being installed. Mills and factories have quickly resumed operations, sometimes under serious difficulties, in an effort to get the workers back on the payrolls in order that they, in turn, can restore their sodden homes to livable quarters.

The general situation

Miles of fresh fill and new ballast indicate the amount of railroad reconstruction that has taken place through the bottomlands. New cables, often laid along the track, replace the tangled mass of telephone, telegraph and signal wires that hang from broken or uprooted poles, supporting furniture, bedding and other debris in grotesque manner. Low-lying highways carry warning of rough pavement or soft fill, though maintenance crews are rapidly restoring the long-inundated roads to normal condition. Freight yards are still full of misplaced freight cars that were tossed around like corks by the flood's fury. Spoilage of freight in transit is one of the high water's heavy toll.

All through the flooded area the scene is the same—shacks and older buildings wrecked and piled up in confusion, porches torn away from the better homes, while storefronts and house windows smashed by floating debris stare vacantly awaiting overworked glaziers who bring truckload after truckload of new glass into the stricken communities.

Mud is happily absent from most of the flooded areas. An almost uncanny freedom from the usual smelly deposit of silt and slime—except in those un-

INSPECTION CREWS equipped with safety devices are making an underground examination of 43 miles of large brick sewers in Louisville to determine possible damage by the flood.

LOUISVILLE'S INDUSTRIAL AREA was hard hit by the flood. Rehabilitation is quite a job here, as is indicated by this view taken after the crest had passed.

U. S. Army Photo

U. S. Army Photo

MANY SMALLER TOWNS suffered relatively more than did the larger cities. Brookport, Ill., shown here, was one of those completely inundated. Adequate flood protection for towns so situated is a serious economic question.

fortunate sections affected by bursting oil storage tanks—is one of the outstanding characteristics of the flood. Lack of mud has been of great aid in speeding up the rehabilitation work.

Another characteristic of the flood was the long duration of high stages. No flashy rise and quick fall was this flood—it was a long, drawn out soaking one, most discouraging to those routed from homes and places of business.

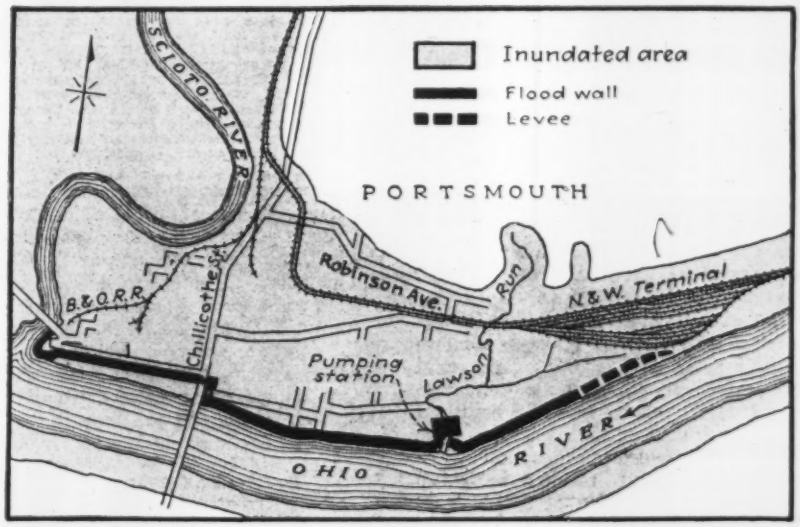
Total damage beyond estimation

The total loss by flood damage in the Ohio valley will never be known. To the direct damage to structures of all kinds and their contents, streets and roads, railroads, utilities, water and sewerage services, must be added the intangible loss of wages and business. Also in the flood's toll must be included the cost of rescuing and taking care of thousands upon thousands of refugees.

The greatest item of loss is that of homes and stores and their contents. Next in line are the utilities—telephone, telegraph and power services. Industries, railroads, highways and streets likewise suffered severe damages.

Actual cost figures are impossible to obtain. Indications of the total damage can be based upon a few loss estimates. For example, a damage survey made in Paducah, Ky., under the direction of City Manager L. V. Bean places the flood loss there at $27,610,000. This estimated loss is 50 per cent greater than the entire assessed valuation of all real and personal property in the city, placed at $18,089,155 in 1936. No comparable estimate is available as yet for Louisville, but James B. Wilson, city engineer, places the damage to municipal property alone, and at that excluding sewers, at $3,525,347, of which $1,098,546 is for streets and alleys. In Portsmouth, Ohio, City Engineer Charles S. Stevenson reports an estimated total damage of $16,429,300.

Of the larger cities, Paducah, Louisville and Portsmouth were stricken the hardest. Total damage will probably run highest in Louisville, but Paducah suffered most in relation to size. A score or more small towns and villages, which received scant attention in the press, were badly hit; some were almost entirely wiped out. For total destruction and desolation Lawrenceburg, Ind., and West Point, Ky., are the worst, for these towns caught the full fury of the swift current, and virtually every home and store was wrecked. Other towns, such as Newport and Dayton, Ky., North Bend, Marietta, and Gallipolis, Ohio, Shawneetown, Golconda, Rosiclare and Metropolis, Ill., were entirely inundated.



PORTSMOUTH'S FAMOUS RIVER WALL was overtopped by 12 ft. and the floodwaters swept through the entire business and industrial areas and part of the residential section. The only part of town to escape was the hill residential area, lying to the northeast of Robinson Ave.

Failure of power, water supply and communication services added to the suffering. All too many cities along the Ohio have their water plants located at the river edge, unprotected against high waters. Many smaller towns depend on wells for their water supply, which naturally became useless upon flooding. Yet despite lack of water, contamination of supplies and unusual exposure of thousands of citizens, the health situation throughout the flood was excellent. Compulsory typhoid inoculation was required of all refugees and most other affected residents heeded the warning of health authorities and were inoculated.

U. S. Army Photo

WATERWORKS are usually located at points vulnerable to the flood's attack, and their failure always adds to the suffering of stricken communities. This view is at Evansville, Ind.

Details of rehabilitation—Paducah

In Paducah restoration and rehabilitation are under the general direction of City Manager L. V. Bean and Gus Meyer, of the National Red Cross headquarters. Assisting these two are C. J. Rhodes of the U. S. Engineer Department office at Paducah, and Capt.

PADUCAH'S STREETS looked like this for three weeks, and the flood remained close to crest levels for ten days. The long soaking received by houses and buildings intensified the damage by submergence (left). **MANY OLDER BUILDINGS** could not stand the effects of flooding and collapsed when foundations were weakened. This view happens to be in Portsmouth, but it is typical of similar scenes in many other towns (right).

Miles Reber, of the Huntington District Engineer office.

The long soaking the city received intensified the damage from submergence. The river rose above flood stage (43 ft.) on Jan. 17, and did not return to its banks until Feb. 21, just five weeks later. For more than three weeks water was in the city streets. The peak stage of 60.8 ft. was reached Feb. 2 and 3, though the water remained within a foot of this stage for ten days. The previous record height was 54.3 in 1913.

Relatively, more of Paducah was affected than any other large community, for some 7½ sq.mi. of the total area of 8½ sq.mi. of the city was inundated; 90 per cent of the buildings and 95 per cent of the population were affected. Compulsory evacuation, while not fully effective, resulted in 32,000 of the total population of 34,500 leaving the city.

Records show that the citizens scattered to 82 outside communities. The biggest job of the Red Cross is to get these people back to the city and to take care of them until their own homes are habitable. A tent city has been established for returning negro refugees, while schools are used for white refugees.

Pure water supply was restored on Feb. 22, though water for sanitary purposes only was available in the mains several days earlier. Lack of water hampered the clean-up work. It is believed that the water mains and sewers came through in good shape, though close inspection of these services has not yet been completed.

A system of inspection of property was quickly established. The firms of Brussel & Viterbo, consulting engineers of St. Louis, Pleitsch & Price, architects of St. Louis, and G. Tandy Smith, architect of Paducah, were called in to assist the city building health and plumbing inspectors in making door-to-door surveys of all buildings in the inundated area. Houses and buildings unfit for occupancy were so marked and cannot be occupied until approved repairs have been made. Those beyond repair have been condemned.

The Kentucky Utilities Co. cut the service wires of every house and building, and will not restore service until the wiring in each case has been checked, repaired and approved. Gas and plumbing services are likewise inspected and approved before being used.

As usual throughout the flooded area, WPA forces are doing the cleaning up. First they were used to alleviate conditions dangerous to life or property, then were placed on the mopping up. All public buildings and property are being cleaned up by WPA, and this organization furnishes the labor and trucks necessary to haul away the tons of debris taken from private property by individual owners and piled along the curb. The WPA force in Paducah numbers about 1200.

Louisville's troubles not yet over

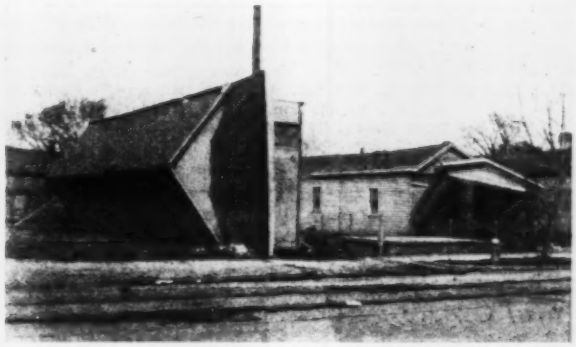
Louisville, while not suffering relatively as great at Paducah, will pile up the greatest total loss of any city in the valley. Hundreds of business and manufacturing establishments and 64,800 homes must be cleaned out, repaired and restored to normal condition as the result of flood waters that raced through two-thirds of the city's area to 40.1 sq.mi. The waters swept into the city through the Beargrass Creek outlet section, known locally as the Point, and through the entire western half of town; the Shippingport district received the brunt of the high waters in this section.

How little the extent of the flood to come was realized at the start is shown by city engineer James Wilson's futile efforts to protect the Point to El. 440 by sandbagging the levee along Beargrass Creek. He soon gave up as the waters rose higher and higher, eventually reaching El. 460.4. The peak stage was 57.4 (upper gage) on Jan. 27, as compared with the previous high record of 46.7 in 1884.

At present a survey is in progress to determine the loss to private property in Louisville. Various estimates have been made, some as high as $100,000,000, but they are pure guesses. Mr. Wilson places the damage to streets slightly in excess of one million dollars. However, some $600,000 of this is damage to streets that were never flooded, but which were torn to pieces by concentrated emergency traffic, including crawler tractors. Woolsey M. Caye, chief engineer of the Louisville Sewerage Commission, has started a number of crews inspecting 43 mi. of large brick sewers. Until this inspection is completed, there is no estimate available as to damage to these large mains, though indications are that several have been seriously affected. The deep concrete sewer and its branches built in tunnel underneath Fourth St. has been inspected and found to be in good shape except for numerous blown-out building connections.

However, perhaps the greatest and certainly the most uncertain damage is to building and street foundations. Louisville rests on a deep sand bed; all building foundations are spread footings. Naturally the underground water table rose to high levels during the flood. The uplift pressure blew in scores of basement floors and cellar curtain walls, especially those under the curb lines. Thus an incalculable number of cubic yards of sand was dumped into basements. Then, too, where deep sewer connections were blown loose by inside pressures more sand was disturbed and displaced. As a result, there is an unknown number of undermined areas beneath the streets. The pavement on about half the length of Fourth St. from Broadway north has already been blocked up by timber cribbing. Most of the areas so treated were revealed by sunken manholes, pavements or sidewalks. Yet there must be numerous other undermined street areas not yet revealed, and authorities admit it may be months before the full extent of undermining is known. An unusually durable pavement slab is carrying traffic over these potential damage spots at present.

To repair the damage connections to the Fourth St. sewer tunnel, shafts



CLEARING AWAY THE DEBRIS is always the first step in rehabilitation after a flood. This is the way some of Cincinnati's streets looked when the high waters receded (left). THE FLOOD WATERS were too much for many of the smaller houses. This view of an overturned cottage in Portsmouth is a duplicate of similar scenes throughout the Ohio Valley (right).

are being sunk as sheeted pits to the trunk line 45 ft. below the surface.

Despite the collapse of cellar walls and floors, there has been remarkably little settlement of buildings, chiefly because the spread footings go much deeper than the basement floors. One interesting case of settlement is that of the Kaufman department store on Fourth St., a six-story structure of brick bearing walls and wood floors carried on cast iron columns. The columns rested on small square brick plinths, which failed completely under the disturbance of the bearing sands, while the outsidewall footings held their place. Under a contract with the H. F. Friestedt Co. of Chicago, the columns have been jacked up and new concrete footings are being placed under them. Though the center columns settled as much as 11⅞ in., no serious damage to floors or ceilings is noticeable. The store opened up for business as soon as the floors had been leveled.

Portsmouth wall becomes a weir

The famous river wall in front of Portsmouth, which has so often in the past protected the city against floods, became a submerged weir as flood waters surged 12 ft. over its top. Though the overtopping was anticipated by City Engineer Charles S. Stevenson, who opened the sewer valves to flood the city gradually, the river rose so fast that the wall was topped long before backwaters had built up much of a head. As a result, the first flow over the wall created a raging torrent through the streets, causing much damage, especially to the poorer structures in the low-lying parts of the city. Except for one or two small towns further downstream, the physical damage in Portsmouth is the greatest in the valley.

The top of the wall is 62 ft. on the local gage. Last year the flood lapped the coping with a stage of 59.4 but the recent high stage of 74.2 surpassed all previous records. In 1913 the water rose to 67.9 which prompted the citizens to start work on the wall. They figured that the 1913 level was a long-time record, and economic considerations limited the height of walls to 62 ft. (*ENR*, May 7, 1936, p. 669). The concrete wall withstood overtopping without damage except for minor washing out of the back berm. At the junction of the wall and levee about 80 ft. of the earth embankment was washed out, causing some damage to the adjacent N&W RR. yards. About 800 ft. of new 12-ft. brick sewer, not yet backfilled, collapsed.

The extent of the flooded area is shown in the accompanying map. In the main business district the shallowest depth of water was 8½ ft. at Sixth and Chillicothe Sts. At Third St. it was 18 ft. deep, and at one intersection in the eastern residential section it was 24 ft. over the curb. Portsmouth is an industrial city, and its poor, in the lowlands, is least able to withstand the shock of flood.

The water pumping plant failed, but a reservoir supply, doled out a few minutes each day, lasted through the emergency. The steamer "Copperloy" was loaned by the Wheeling Steel Co. to furnish steam for pumping out the water plant dry well, after which the pump waters were replaced and the plant went back into service on Feb. 2.

About the same routine of inspection as adopted at Paducah is in force. More than 2,200 WPA workers are busy cleaning up the streets and public property. A WPA project, under way when the flood struck, will provide a concrete sheet pile cutoff along the levee at the upstream end of the river wall and along the railroad embankment on the Scioto River front. Previously much trouble had been experienced with seepage through these embankments at high water stages. Four of the five sewage pumping plants are being modernized as WPA projects.

Look to WPA for repairs

Throughout the valley the stricken communities are looking to WPA to restore the damaged public property. Everywhere projects are being filed for repairs to streets, walks, waterworks, sewers, police and fire alarm systems, schools, hospitals and other public buildings.

As rehabilitation progresses, the residents of the valley are devoting more attention to protection against future floods. Naturally the report of Col. R. G. Powell, U. S. Division Engineer at Cincinnati, outlining protection of the entire Ohio watershed, is receiving much attention, though details as yet have not been released. Paducah citizens lost no time in advocating floodwall protection for their city, long before the Powell report was submitted. While the various communities have their own ideas of what should be done, there is no doubt that they all are in favor of some kind of flood control to be carried out at once by the federal government.

TYPICAL FLOOD LOSSES IN THE OHIO VALLEY

Paducah, Ky. (pop. 34,500):	
Total area, sq. mi.	8.5
Area flooded, sq. mi.	7.5
Persons affected	32,700
Refugees from city	32,000
Damage:	
Private homes and contents	$15,000,000
Retail stores	4,000,000
Factories and shops	980,000
Wholesale and jobbers	450,000
Merchandise, incl. foodstuffs	4,100,000
Sewers	200,000
Waterworks	50,000
Bridges	175,000
Streets	1,175,000
Mun. buildings	120,000
Gas and electric util.	100,000
Phone service	200,000
Schools	550,000
Autos and trucks	450,000
Total	$27,610,000
Louisville, Ky. (Pop. 330,000):	
Total area, sq. mi.	40.1
Area flooded, sq. mi.	27
Homes affected	64,800
Persons affected	250,000
Damage to streets	$1,098,546
Damage to other city property, excl. sewers	2,426,801
Portsmouth, Ohio (Pop. 45,000):	
Flooded area, sq. mi.	12
Refugees	34,248
Homes affected	6,234
Houses destroyed	500
Houses condemned	620
Damage:	
Houses and garages	$2,943,600
Household goods	1,000,000
City property	316,200
Utilities	2,000,000
Industries	1,500,000
Merchants	4,292,600
Professional	150,000
Churches	100,000
Autos and trucks	125,000
Fire	2,500
Economic	4,000,000
Total	$16,429,300

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March 11, 1937

Sober Thought Wanted

WHEN WORD of the floor scaffold failure on the Golden Gate Bridge at San Francisco flashed across the country on Feb. 17, the first thought to the mind of every engineer and contractor was "How can we prevent such a thing happening again?" Not so with the California Industrial Accident Commission, charged with investigating the disaster. Sensing the political capital inherent in dramatizing death, it called an immediate hearing, arranged to have it broadcast and from all reports conducted it as a public spectacle. To pillory the contractor rather than to investigate the cause of the collapse was plainly the object in view. If the commission is a judicial body, it is no credit to its calling; if it is merely an investigating commission it showed complete lack of appreciation of its function. The construction industry can but hope that the commission will come to its senses and bring sober thought to the problem. The issue in analysis of an accident of this kind is not to find someone to blame but to determine causes, that they may be eliminated in the future.

Find the Causes

INSOFAR as determination of causes is concerned the scaffold failure disaster on the Golden Gate Bridge is similar to some of the recent airplane crashes; vital parts of the wreckage are missing and most of the persons directly concerned are dead. Careful deduction from available facts therefore is necessary. As the facts are incomplete perhaps the exact causes never will be proved definitely, since so much must be based on assumption. But it is important to consider why cast aluminum was used in the scaffold handgers instead of a high-strength aluminum alloy better suited to resist impact and emergency stress. If the hangers were adequately strong to carry the ordinary direct stress for which they were designed, then it becomes necessary to investigate the safeguards that were used to assure that no unusual stresses would be present. Carelessness of the workmen in securing the supporting hooks is another important factor to be considered. Unless we can learn from disaster how to prevent its recurrence, construction will be thwarted in its sincere efforts to make its activities more safe.

On the Bottom

OCEAN OUTFALLS require joints far superior to those adequate for the ordinary trunk sewer. Proof is found in the frequency with which joints in large ocean outfalls fail; joint failures are apt to occur even while the pipe sections themselves are still in perfect condition. The successful joint not only must resist aggressive water and remain tight under settlement but also must be adapted to submarine assembly. The joint must be simple to make up after the pipe section has been lowered to place in the trench, since the work necessarily is done in the darkness of muddy water where tools can be used only by feel and there is no chance for visual inspection. These factors were recognized when the ocean outfall described in this issue was designed. Accordingly the joint problem received thorough study, and it proved possible to combine the economy of a reinforced-concrete pipe barrel with the safety of a cast-iron joint and an assembly and maintenance procedure involving access to the joint from the inside only. The construction used is a distinct improvement on previous practice; if advance indications may be relied upon a long-life type of construction for ocean outfall service has at last made its appearance.

Water in New Jersey

HOPEFUL SIGNS pointing toward correction of the serious water-supply situation in New Jersey appear on a long-darkened horizon. As a result of conferences between the State Water Policy Commission and the North Jersey District Water Supply Commission, measures were introduced in the state legislature last week which would consolidate these agencies for unified control of water resources. This reorganization is intended to bring harmony of action among factional groups whose overlapping authority and conflicting viewpoints in the past have nullified attempts to establish basic water policies. For years there has been controversy over what sources and storage sites should be chosen, and who should decide; meantime population increases and industrial uses were building up a demand for which no reserves are now available. It is known that the North Jersey metropolitan area as well as sections of the southern half face a water shortage, and that it will become necessary to interconnect existing municipal and private systems before new supplies can be brought in. In view of the recent agreement of the chief agencies concerned, nothing now stands in the way of constructive action except quick ratification of the pending legislation and a determined sense of duty on the part of those who will be chosen to carry out a vital public mandate. Granting this, New Jersey water authorities have a rich opportunity to make amends for long-continued procrastination.

Practice Revolutionized

IT IS A MATTER OF OLD EXPERIENCE that disaster is at best a nine-day sensation, and that public clamor for reform to prevent its recurrence quickly subsides. For once, however, this sorry history was not repeated. In the general destruction of schools in the Los Angeles region by the 1933 earthquake, the ruin was so great that something had to be done—and by good fortune the officials in charge determined to make a thorough job of it. The result is that the school plant of the region has been revolutionized. How great an accomplishment this was, in its administrative and financial aspects as well as the structural and safety aspect, is brought out impressively by the two articles in the present issue and a third that will follow later. In the background of the achievement is the fact that long prior to 1933 California structural engineers had been working to formulate practical earthquake-resistant methods of design and construction; the result is now part of the state's requirements for school buildings. The importance of this work and the force of the lesson contained in the articles which we are publishing may be appraised

by the example of the Helena, Mont., school building that, though designed under PWA auspices with every intention to produce the most modern building, and constructed in full knowledge of what the earthquake had done in Los Angeles, was yet so flimsy that it was shaken to pieces when an earthquake came. The revolution accomplished in Los Angeles shows the way to forestall such failure. The shocks this week in the Middle West point to the need of applying the Los Angeles experience widely.

The River's Rights

FLOODS of the kind that swept through the Ohio Valley a few weeks ago are among the greatest of catastrophies suffered by mankind. But however terrible they are simple phenomena of nature. Rivers were here long before man, and for untold ages every stream has periodically exercised its right to expand when carrying more than normal flow. Man's error has not been the neglect of flood-control measures but his refusal to recognize the right of rivers to their floodways.

In this light the offer of the RFC to help finance the movement of individuals, industries and even whole communities from frequently-flooded bottom lands to perpetually safe highlands is welcome news. It points to a more realistic view of the flood problem than has prevailed heretofore. There is little excuse for the waterfront location of thousands of properties damaged in the recent flood. The Ohio is not a broad alluvial valley but a relatively narrow gorge bordered by safe highlands, and movement to the hills in most sections is not difficult.

Traveling down the Ohio during the recent flood one could notice scores of farm homes completely inundated though standing only a stone's throw from high ground. Villages were flooded, while a few hundred yards away dry land rose above the muddy waters. Is it sound economics to let such property be damaged year after year, to rescue and take care of the occupants, to spend millions for their "local protection", when a slight shift of location would assure safety?

Is it right that the country as a whole should pay for local protection of such vulnerable spots as Wheeling Island, where 10,000 people insist on occupying a low-lying island that is hardly more than awash at low water? Is it right to perpetuate decrepit slum districts in the flood zones of the larger river-bank cities, peopled by masses that become refugees and relief cases in every high water? Portsmouth has answered this question by declaring its intention to convert its low-lying sections into a park.

The federal government has never seen fit to establish floodflow boundaries for its rivers, though in the interest of navigation it has long assumed the right to mark low-water channels. Pierhead and bulkhead lines are laid out in every harbor and navigation clearances are set upon which no encroachment may be made. Yet people and industries have been permitted to occupy normal flood channels, and flowageways have been restricted by filling in and by commercial development without federal protest.

It may not be possible at this late date to restore the floodways to the rivers completely. Occupation and development of the flood plains have proceeded so far that we are now forced to spend huge sums to control floods. Plans for reservoirs and floodwalls are commendable; their cost, staggering though it may be, is less than the loss caused by one big flood. Yet in planning flood relief let us remember that the river has rights, and these rights must be respected.

Shall Subsidy Replace Regulation?

SEVERAL current government proposals embody the subsidy method of bringing about reforms that hitherto have been considered a matter for economic forces and regulation. By the new method special classes of citizens are to be paid to do what the government wishes done. In its general aspects the new course of action concerns the public interest at large, but it has special significance for engineers because their work is affected. Further substitution of subsidy for regulation is very likely to follow, once the new departure becomes established.

Under the housing bill, now in Congress, rent subsidies are to be paid for the benefit of occupants of low-cost housing. If slum tenements can be wiped out in no other way, it means that regulation has failed as a device for keeping dwellings up to a minimum standard of decency. Yet at the very moment that the rent subsidy bill is put forward, the authorities of New York are deliberately postponing the enforcement of sanitary and fire laws designed to protect tenement dwellers—laws that have been flouted for nearly forty years.

If sound regulation is not to be enforced, if direct control of the evil therefore is a failure, what prospect is there that rent subsidies for new tenements can drive the slum tenement out of existence? The prospect appears to be small; the subsidized tenement may force down the present slum rents a trifle, but it is unlikely to catch up with the situation—most of all under the proposed 60-year repayment plan, a plan better adapted to develop new slums than to eliminate old ones.

But while subsidies as compared with regulation of the tenement evil seem to face a losing fight and contain no promise of controlling the underlying evil of land-value inflation, they carry the threat of destructive interference with the normal progress of construction. By discouraging private building the subsidy system is likely to react harmfully on all types of construction.

Subsidies of another type are contemplated in the soil-control legislation which the President has just recommended to the states. Here again, regulatory action in the interest of the people as a whole is discarded for benefit payments. Engineering and construction interests have reason to apprehend this new procedure quite as much as the rent subsidy plan. If rural zoning and the effective protection of land and streams are to be accomplished by subsidy, many construction activities that now rise from private initiative are in danger of being enmeshed in governmental logrolling and bureaucratic determination.

It is something of a sidelight on the situation that New York City is planning to ask for $30,000,000 from the national treasury as a contribution toward building the Hamilton Ave. Tunnel, a project that, it has been said, cannot otherwise pay its way. Such requests to support uneconomic improvements are not likely to end as long as subsidy payments are recognized as a regular method of government.

CURRENT NEWS

House Group Urges Works Plan

Congressman propose solution of unemployment problem based on large-scale flexible program of public works

The use of an extensive public works program varying in magnitude according to the volume of unemployment was proposed March 8 as a solution to the unemployment problem by sixteen members of the House of Representatives who stated they intended to press for such a plan and claimed the support of 125 embers of the House. A statement issued by the group said that the program, which is intended to be supported by taxation rather than by borrowing, should be based on the following principles:

Jobs should be provided for all who are able and willing to work and who cannot find private employment.

The work is to be "useful, productive and efficient."

There should be no requirement that workers be taken off relief. Hiring would be on the basis solely of need for a job and ability to do the work.

Facts should be obtained concerning the amount of unemployment and the opportunities for employment in private industry, and the works program would be enlarged or cut down according as unemployment rises or falls.

There should be no made work. Enough money must be appropriated to pay for materials and equipment so that projects of a socially valuable nature may be undertaken.

The work should be planned so that it will develop and maintain those skills and abilities which are most likely to be in demand in private industry.

Projects are to be so planned as to stimulate all industries.

The recreational, theatrical, educational and fine arts projects should be continued.

The program should be financed primarily with federal funds, with local sponsors' contributions based entirely on their ability to pay.

The program should be financed by "equitable taxation on the basis of ability to pay" rather than by borrowing.

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Rock Slide Kills Seven On Montana Dam Project

Seven employees of the Phoenix Construction Co. were killed, and three others were injured on March 3 when three slides of rock crashed to the bed of the Flathead River near Polson, Montana, where the Rocky Mountain Power Co. is building an $8,000,000 dam.

The victims were cleaning up an excavation for the dam preparatory to the placing of concrete when the rock and dirt at the top of the canyon gave way. All excavating equipment had already been removed. The slide was attributed to recurrent thaws and frost which loosened the earth on the canyon walls.

The dead men were buried under the first slide. A second slide occurred while an attempt to rescue the buried men was in progress and three more were injured. Shortly after these three were rescued, a third slide occurred but did no damage.

The slide constitutes the first major accident in the history of the project, which was started in 1930 but stopped a year later and resumed only last year. The output of the dam is intended to provide power for various Montana properties of the Anaconda Copper Mining Co.

Bonneville Power Bill Is Modified

Major General Markham, Chief of Engineers, on March 9 proposed an amendment to the Bonneville power sales bill (*ENR*, Feb. 25, 1937, p. 312) providing that the army assume the entire operation of the power plant as well as of the navigation dams. The plant would be so operated as to produce the amount of power demanded by the market, this to be determined by the proposed Columbia River Administrator.

This would leave all phases of dam operation under the control of the army and would give the administrator jurisdiction over power after it leaves the bus bars.

General Markham stated that the change had been wholly agreed to by President Roosevelt. The amendment was accepted by Representative Smith who introduced the original bill, which embodied the recommendations of the Ickes power policy committee.

Cornell Engineering School Gets Mysterious Gift

A gift of $35,000 has been made to Cornell University for the benefit of the endowment fund of the college of engineering by a mysterious benefactor who signs himself L. H. Anon. Two gifts have been received from the same unknown source in the past, and in accordance with the donor's expressed wishes the university has not sought to establish his identity.

President Farrand has asked the press to express the thanks of the university. He stated that the $35,000 would be used to begin an endowment fund for the college of engineering.

Move Flood Towns To High Ground

Government agencies arrange loans for moving buildings out of frequently flooded regions

Voluntary removal to higher ground of those sections of Ohio Valley communities most subject to floods will be facilitated by a joint program announced by the RFC Mortgage Corp., the Federal Housing Administration, WPA, and the CCC.

In making rehabilitation loans under the authority recently granted by Congress, RFC will finance up to 80 per cent of the cost of new homes built on high land, charging 4 per cent interest and spreading amortization over a 20 year period. The loans will be insured by FHA. The WPA will aid municipalities in opening, grading and improving new streets and in providing drainage, sewers and other municipal services when these projects can be carried out with relief labor; WPA will also contribute somewhat toward the cost of materials used. CCC labor will be made available in certain cases when it fits in with the regular program.

It is hoped that the communities concerned will take steps to abandon completely the more hazardous areas frequently affected by flood waters. When this is done, loans will be made for creating entire new residential districts. Towns having low-cost housing authorities will be able to use the existing agency for this purpose.

Loans will be available to investors having rentable property in hazardous locations as well as to home owners, provided that rent levels are kept within the low-cost range. In such cases the limit of financing is set at 70 per cent of the cost of new construction on safer ground.

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Big Public Works Program Announced in Poland

A recently announced public works program for 1937 in Poland will involve the expenditure of about $160,000,000. This is a continuation of a four-year investment plan to spend $360,000,000 announced last June.

The original four-year plan has been greatly enlarged and now contemplates the creation of a new industrial zone in the economically depressed area in the central southern part of Poland centering around the town of Santomirz. Railroads, factories, natural gas lines, water power stations, and electric plants will be built in or near this area.

The main industrial region is now in upper Silesia and Dabrowa, close to the German frontier. It is planned to concentrate industrial work around Santomirz.

Wide World Photo

SETTING TIMBER FRAMES FOR QUEENS MIDTOWN TUNNEL

TIMBER FRAMES for the Manhattan ventilating shaft of New York City's Queens midtown tunnel, under the East River connecting Manhattan and Queens, were placed Feb. 23. Sinking of the shaft by the Triest Construction Co., the contractors, started less than four weeks before the setting of the frames.

The framing was set after the shaft had been excavated to rock. Rather than drive the steel sheathing before excavating, the shaft was excavated 20 ft. to rock, and cleaned out full size. Then two prefabricated 72-ton timber frames, each frame in four parts, were set in the shaft by cranes, and the steel sheathing was installed.

The Manhattan ventilating shaft, when completed, will be 112 ft. deep, 60 ft. wide and 110 ft. long.

General Markham Denies That Dams Caused Ohio Flood

Apparently in answer to claims made by the Jefferson County Grand Jury, Major General Markham, chief of engineers, U. S. Army, has issued a statement denying that the navigation dams in the Ohio River had any effect on the height of the flood. The Grand Jury had held that the recent flood was caused by the federal dams, claiming that the dams had raised the bed of the river several feet, and asked that the federal government make outright grants in compensation for all property damage and losses of Louisville and Jefferson county residents rather than disaster loans. (*ENR*, March 4, 1937, p. 350.

General Markham's statement follows, in part:

The Ohio River has been transformed into a waterway suitable for barge navigation throughout the year by construction of a series of 47 locks and dams which provide slack water pools at low water and afford a channel not less than 9 ft. in depth. The cost of this improvement has been $180,000,000. Before the improvement of the Ohio River was undertaken by the federal government the depth available to navigation on the worst shoals was but one foot at low water.

These dams are typically constructed of wickets or shutters that are lowered flat on the bottom when the river rises and offer no obstruction whatever to flood flows. They do not cause any deposit of silt in the river bed for the reason that, during the period when the river is carrying any considerable amount of silt, the dams are down and the river currents are unimpeded. Little silt is carried at low water when the dams are up, and whatever minor deposits may be made at such times are carried out with the first rise. The dams when lowered produce no visible disturbance on the river surface. The river flows as smoothly over them as in any other portion of its course.

In the upper part of the river a few dams of a different type have been constructed. These have gates which are raised at high water, leaving a series of piers through which the river flows as it flows through the piers of a bridge. Such dams, while affording a slightly greater obstruction to flood flows than do the wicket dams, have no more influence on flood heights than the many bridges crossing the river. No dams of the latter type have been constructed in the portion of the lower river below Cincinnati and Louisville, at which the flood reached unprecedented heights.

The recent disastrous flood in the Ohio River was due solely to an extended period of heavy rainfall of unprecedented volume. The flood heights were not increasd in the slightest degree by the navigation work.

Government Picks Delegates To Hydrographic Congress

The United States has appointed two official delegates to represent it at the fourth congress of the International Hydrographic Bureau, which will convene at Monaco, April 13. The delegates are Capt. Lamar R. Leahy, U.S.N., hydrographer of the Navy; and Capt. Gilbert T. Rude, Coast and Geodetic Survey, Department of Commerce.

American membership in the bureau was authorized by an act of Congress approved in 1921.

Extra Work Contract Thrown Out

Kentucky court holds work done under unadvertised contract need not be paid for

A Frankfort, Ky., court has denied the claim of the Codell Construction Co. to be paid for $41,000 worth of highway construction, on the ground that the supplemental contracts under which the work was done were not publicly advertised.

The Codell Construction Co. was awarded a contract in November, 1934 on 6½ mi. of grade and drain road-construction work in Pike County on a bid of $118,000; the work was to be completed by November, 1935. When the original contract was about to expire and the work had been completed, the highway commission, on Nov. 12, 1935, awarded two supplemental contracts for $16,000 and $29,500, respectively, covering additional grade and drain construction not included in the original 6½ mi. The first supplemental agreement provided for grading an additional stretch of road at one end of the original project, and the second agreement provided for another stretch at the far end of the first supplemental section; together the two covered about 1½ miles.

When the work was completed, Robert Humphreys, commissioner of highways, refused to order payment for the work. The contractor sought to have the court force Mr. Humphreys to make payment on the ground that the work had been done.

The court held that the highway commission had no authority to make extensive additions to a contract without throwing the new project open for competitive bidding and refused to order Mr. Humphreys to make payment. If supplemental agreements could be made beyond the limit of the original contract, the court stated, there was no limit to the award of road work without competitive bidding. It was ruled that when substantial additions for projects were decided on, the commission must proceed as if it were what in fact it is, a new project.

PWA Rentals Announced On Milwaukee Project

Average rental for a three-room apartment at Parklawn housing project in Milwaukee, Wis. will be $16.20 per month. An additional charge of $6.60 will be made for utility services, including hot and cold water and electric power for cooking and refrigeration.

Announcement of the rentals was made and selection of tenants began as the $2,800,000 project approached completion. The rentals range from an average of $16.20 for the three-room apartment up to $26.78 for a five-room group house; the corresponding utility charges range from $6.60 to $9.80.

Parklawn, the sixth low-rent housing development on PWA's federal housing program, is directly adjacent to a large Milwaukee industrial area. Covering a 42-acre tract of land, it includes 64 fireproof structures in two-story apartments and one and two-story group houses. The buildings are grouped around landscaped courts.

Water Consolidation In New Jersey

New Jersey water works men hear details of proposed reorganization of water control bodies

Outlining a plan of reorganization of existing water control authorities in New Jersey to facilitate constructive development of that state's water supply, George S. Burgess, chairman of the State Water Policy Commission, speaking at the New Brunswick meeting of the New Jersey section of the American Water Works Association on March 3, urged support of pending legislation. The legislation consists of five bills which provide for unified activity of the North Jersey District Water Supply Commission and the State Water Policy Commission. The new set-up would eliminate overlapping jurisdiction, placing the determination of policies and the financing of projects in the hands of the present water policy commission, while the North Jersey district commission would be concerned primarily with construction and operation of undertakings.

The March 3 A.W.W.A section meeting of the New Jersey waterworks men was devoted entirely to a resume of state legislation concerning water development regulation of well drilling and municipal tenure of office measures. The following nomination of officers were made: William P. Conard, president; George F. Wiegard, vice-president, and H. N. Lendall, secretary-treasurer. At the evening session of the meeting, Harry A. Jordan, secretary of the American Water Works Association, spoke on the advantages of a national organization, and F. Wellington Donaldson presented an illustrated lecture on experiences in restoring water services to cities in the flood devastated areas.

Tracing the chaotic situation in New Jersey regarding water supply development, Mr. Burgess pointed out that in 1916 a water supply district law was passed which provided for the development of a mutual supply system by any group of municipalities desiring to do so. This resulted in the formation of the North Jersey District Water Supply Commission which constructed the Wanaque dam project serving several communities in the northern metropolitan area of the state. In a further effort to encourage the formulation of definite plans for statewide water development, a water policy commission was temporarily organized in 1925 and this became a permanent body in 1929. Duplication of authority vested in the two commissions, however, caused constant conflict, and this nullified all efforts toward development of new supplies in the rapidly growing metropolitan area. After repeated attempts over several years to break the deadlock, a conference between the two commissions last summer finally resulted in an agreement on the present plan of consolidation.

The legislation to make this consolidation effective comprises five separate bills and provides, in addition to demarcation of authority, power for the water policy commission to compel interconnection of existing, separate supplies wherever temporary water shortages make this desirable. It is believed that this scheme will furnish temporary relief until new major supply extensions are developed. At the present time there are about 250 separate systems that could be interconnected for this purpose.

The five bills, as reported by the New Jersey Legislative *News*, contain the following provisions:

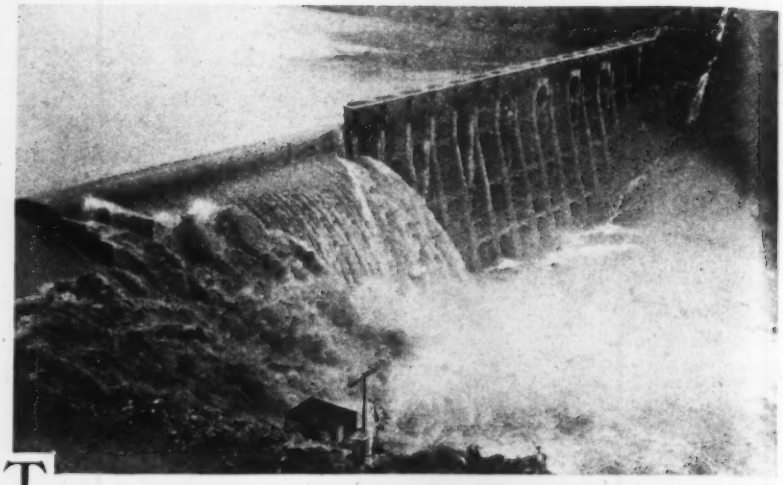
To appropriate $5,000 to the state water policy commission from the Water Supply Fund as the state's share of the WPA water supply interconnection survey. (S-156)

To prohibit the taking of more than 100,000 gallons of water per day without approval of the state water policy commission. (S-157)

To expand the powers of the state water policy commission, adding authority to finance building and consolidation of water supplies. (S-158)

To appropriate $700,000 to state water policy commission to pay initial interest charges and other preliminary costs of new water supplies. (S-159)

To divest district water supply commissions of authority to determine location of surface water supplies. (S-160)



THE SPILLWAY at Hodges Reservoir Dam, a high thin-buttress multiple arch structure near San Diego, Calif., carried a flow of 20,000 sec.-ft. on Feb. 7, 1937. This view shows the dam when the flood had decreased to 10,000 sec.-ft. Strengthening of this structure, described in *Engineering News-Record*, Nov. 5, 1936, p. 644, was completed in December, 1936.

Court Orders That City Stop Stream Pollution

The city of Belleville, Ill., has been given 18 months in which to cease polluting the waters of Richland Creek with raw sewage under an order from the Circuit Court at Belleville. Failure to comply with this injunction carries a penalty of $100 per day. The court, at the same time, awarded farmers whose land is drained by the creek $12,000 damages against the city.

On June 16, 1936, the voters of Belleville defeated a proposal that the city issue $282,000 in bonds to defray its share of the cost of building a $457,000 sewage disposal plant, two outfall sewers and a pumping station. A PWA grant and a tentative contract for the construction of these improvements were cancelled when the bonds were defeated.

Error in New Orleans Report—City Safe Without Spillway

The levees of New Orleans would not have been overtopped during the recent high water even though the Bonnet Carré spillway had not been used, according to advices received in protest to a statement to the contrary appearing in these pages Feb. 25. In reporting flood conditions at New Orleans as he had seen them on Feb. 21, H. W. Richardson stated in effect that the flow through the spillway was lowering the city's stage by 3.3 ft. (Carrollton gage then 19) and as the New Orleans levees were good for only 21 ft., the spillway was saving the city from serious trouble and possibly from submergence.

This statement was in error, for messages from Arthur M. Shaw, New Orleans consulting engineer, Col. W. F. Tompkins, district engineer, Second New Orleans District, and the Mississippi River Commission, place the effective grade of the city's levees at 25 on the Carrollton gage. Mr. Shaw says: "The commission levee grade at upper city limit is El. 25 (25.1 on the gage) sloping down parallel to high water flow line to El. 21 at the lower city limit. Except at a few local points left low for commercial purposes and adequately safeguarded by available materials, all levees are 4 ft. or more above this year's high waters. No water from Mississippi River floods has entered the city since 1849. The Carrollton gage is at the upper city limit, and reports concerning the stage there seldom take into account the flow slope along 12 miles of city front."

The Mississippi River Commission points out that: "Top of levee at New Orleans corresponds to 25 ft. on the gage. The 3.3-ft. lowering effected at the city is therefore entirely within the present freeboard; that is, without the spillway in operation the stage at New Orleans would have been 19.1 (peak stage) plus 3.3, or 22.4 on the gage, 2.6 ft. below top of levee. In 1922 a stage of 21.27 was registered and nothing happened, and in 1927 the stage reached 21.0."

New Wage Agreements Raise Steel Prices

The recent industry-wide wage increase of a flat 10c. per hr. for all steel mill workers has resulted in a considerable rise in the price of steel products, announced last week in Pittsburgh. Similar announcements of price increases are expected from the other steel centers. Some of the new prices, all base mill quotations at Pittsburgh, are as follows: Structural shapes and plates, $2.25, an increase of 20c. per 100 lb.; reinforcing bars, ¾-in. billet, $2.60, an increase of 40c. per 100 lb.; rivets, ½-in., $3.25, or 5c. more than the old price; wire nails, an increase of 35c. to $2.75 per 100 lb.; standard steel rails, $42.50 per ton, an increase of $3.50. Corresponding increases are expected in the price of steel sheetpiling.

According to the American Iron & Steel Institute, the former average hourly scale of 500,000 steel workers of all classes was 72½c. per hr. The 10-cent increase raises the average to 82½c., a rise of 14 per cent. The corresponding rise in steel prices ranges up to 18 per cent for reinforcing bars. A spokesman for the Institute pointed out that the reduction in working hours from 48 to 40 hr. per week, as called for in the new labor agreements, will affect the cost of production as much as will the increase in hourly wages. However, most steel mill workers have not put in a 48-hr. week for several years. The Institute estimates the average work-week for common laborers in the industry in January as 40½ hr. Most of the higher-paid skilled workers have been working 48 hr., and a shortage in this class of labor already exists. Probably many of these will continue to work 48 hr. and receive time and a half for all time over 40 hr., in accordance with the new agreement.

Steel production high

The Institute announces that the industry was operating at 84.16 per cent of capacity during February, the highest in years. In that month production averaged 1,106,165 tons a week, the greatest for February in the history of the industry. Production in January was also the largest for that month with an average weekly output of 1,690,232 tons.

Water Conference Announced By New Jersey Engineers

A statewide conference of public officials and municipal engineers on stream pollution and water supply, to be held in Trenton, N. J. March 19, is being sponsored by the New Jersey Association of Municipal Engineers, an affiliate of the New Jersey State League of Municipalities.

The one-day session will be divided into two parts. During the morning, which will be devoted to the subject of stream pollution, delegates will hear papers read by Dean Thorndyke Saville, New York University college of engineering; Charles A. Holmquist, director of the division of sanitation, New York state board of health; and Prof. Thurlow C. Nelson, Rutgers University.

After luncheon, at which Governor Hoffman of New Jersey will speak, the session will reconvene to consider the topic of water supply. At this session papers will be delivered by Nathan B. Jacobs, consulting engineer of the National Water Resources Board; Howard T. Critchlow, engineer of the New Jersey State Water Policy Commission, and Frederick O. Runyon, consulting engineer.

Johns Hopkins Engineer School Celebrates 25th Anniversary

The 25th anniversary of the Johns Hopkins school of engineering was commemorated Feb. 19-22 in a special program during the 61st commemoration day exercises of the University.

At the concluding ceremony Feb. 22, the honorary degree of doctor of laws was confered on Dr. Karl Compton, president of the Massachusetts Institute of Technology. The degree of doctor of engineering was conferred upon John E. Greiner, Baltimore engineer and designer of bridges; Carl C. Thomas, first professor of mechanical engineering at the engineering school and now vice-president of the Dwight P. Robinson Co.; Herbert A. Wagner, president of the Consolidated Gas Electric Light & Power Co. of Baltimore and inventor of the first successful single phase alternating current motor; and Abel Wolman, chief engineer of the Maryland state department of health and chairman of the water resources committee of the National Resources Committee.

A technical session was held on the morning of Feb. 20 at which seven papers were read, among them a paper, "Accomplishments in Water Purification," written by Prof. John H. Gregory and completed the day before his death Jan. 18. It was read by one of his associates.

Flood Damage on Indiana Roads Will Cost $250,000

Surveys by the Indiana state highway commission show that repairs of flood damage to the state highway system will cost $250,000 and that an equal amount ought to be spent to prevent recurrence of such losses, it was reported March 4.

About 325 miles of highways were submerged for days at a time. Most of this mileage was along the Ohio River and the lower part of the White and Wabash rivers. At one time it was estimated that normal traffic was affected on 1,300 miles of state highways.

The largest single item of damage on the highway system was the washing out of a bridge and part of a fill west of Brownstown, replacement of which is estimated to cost $50,000. Washing of fills and damage to shoulders will cost about $35,000; slides which took away part of the highway or covered the traveling surface cost nearly $45,000, and damage to highway surfaces has been placed at more than $11,000.

Recommendations have been made, after a survey of the flood area, for construction of new bridges to take care of overflow waters and for additional protection of fills.

New York Engineers Act on Law Changes

New York Professional Engineers make recommendations on bills pending before New York Legislature

Consideration of legislative bills directly or indirectly affecting engineers made up the principal part of the program of the one-day winter meeting of the New York State Society of Professional Engineers held at Albany, March 6. Bills now before the state legislature had been reviewed by the executive board of the society at its meeting which began on the afternoon of March 5, and the board's action was reported to the general meeting by Arnold G. Chapman, chairman of the legislative committee, and now charged with direction of the legislative office recently set up in Albany by the society.

The society went on record as favoring the following proposals now before the state legislature: a bill to require supervision of building construction by a registered architect or licensed engineer and requiring certification by that architect or engineer as to the adequacy of the plans and the completeness of their execution before a certificate of occupancy can be isued; a bill to eliminate undesirable elements in the exemption clauses of the present engineer license law; a bill to require that men hereafter newly appointed to the position of county superintendent of highways (or to positions having corresponding responsibilities) be licensed engineers; a bill empowering public officials to employ consulting engineers to pass upon public undertakings put up to them for approval and financing; a bill to permit the attorney-general to obtain temporary injunctions to restrain the practice of professional men charged with violation of any of the state's professional practice acts; a bill to authorize the superintendent of public works to construct sidewalks along public highways.

Opposition was expressed to bills that would limit the drawing of legal documents to lawyers, thus keeping engineers and architects from writing contracts; a bill requiring certification of real-estate appraisers; certain wording in a bill to license stationary engineers; and the wording of a bill to license builders in New York City.

The legislative committee reported no action on the part of the board on a bill recently introduced to limit the employment of consulting engineers by public agencies that have engineers on their own staffs, but subsequently, following a strong statement in opposition to the bill by D. B. Steinman, the meeting went on record as opposing that bill also.

Arthur Sheridan, president of the National Society of Professional Engineers, reported briefly on the progress that the National Society is making, speaking especially concerning the active interest taken by the state societies in Texas, Oklahoma and Ohio.

The financial secretary of the state society, Ernest F. Fox, reported that the society was in good shape financially. The society now has a membership of 1,521 out of a potential 9,850.

The annual meeting of the society will be held in New York on May 22.

Road Signal Rules Formulated

New York State Traffic Commission reports on rules adopted for traffic signals on state highways

The New York State Traffic Commission has submitted to the legislature a report on its activities. The commission has formulated standard rules for the location and type of traffic signals and signs to be placed on state highways and for the establishment of restricted speed and passing zones. In accordance with the law creating the commission, it has taken over the erection and maintenance of traffic signs and signals on state highways, with all services and materials to be supplied by the division of highways.

The state traffic commission was created by an act of the New York state legislature in 1936; it was empowered to regulate the location, erection, maintenance and removal of all traffic control lights on any state highway outside of cities and to adopt uniform rules and regulations for such signals. It was further empowered to propose speed regulations on state highways and to cooperate in safety program of cities and villages.

The regulations formulated by the commission require that all traffic control lights must be vertical, with red on top, yellow in the center, and green at the bottom, and shall be centrally suspended over the pavement to give a minimum clearance of 14 ft. 6 in. Any signs attached to traffic control signals must be 3 in. in height and must be illuminated, and only such signs are permitted as are considered necessary by the commission. Right turns may be made on a red signal only when a green arrow indicates permission for such turns, this rule going into effect July 1, 1937. Traffic control signals will regulate traffic only at the intersections at which they are located. It is provided that all lights not conforming to these standards will be replaced as funds are available in the division of highways.

All pedestals and stanchions which now exist on or near pavements of the state highways have been ordered removed and replaced where necessary with signs conforming to the standards of the commission. It is required that all traffic signs installed on the highways of the state system shall be illuminated, either by means of a reflecting element set at the base of the sign, by the use of illuminated backgrounds, or by other means. It has also been ordered that signs should be erected instructing motorists to dim their headlights while traversing illuminated stretches on the state highway systems.

School zones

At the request of local agencies and if the commission finds it desirable control signals will be set up in the vicinity of a school. Traffic will be controlled in such locations either by a semaphore, which must be in the center of the pavement, must be manually operated by an adult, and must be removed when not in use, or by a traffic light, which must conform to the regular standards, must be manually operated, and must be shut off when not in use.

Restricted speed zones will also be set up, in the neighborhood of schools which are on highways outside of cities, for a distance of 500 ft. on either side of the school. Signs must be set up indicating the existence of the restricted zone and must be hooded outside of school hours.

The commission has directed that various locations be studied to determine whether speed should be regulated there, and, if necessary, speed zones will be established in those areas. The commission has further established certain zones to be known as no-passing zones and to be suitably marked as such. In these zones no vehicle shall overtake or pass another vehicle proceeding in the same direction.

Certain amendments to the act setting up the commission are proposed in the report. These amendments, which would clarify the powers and procedure of the commission, are now in legislative committee. The commission has endorsed by resolution legislation providing for the use of the highway funds for construction of sidewalks in rural areas.

Montana Department Merger Considered by Legislators

The Montana state legislature and Senate, now in session, are considering measures which, if approved, would consolidate the state highway department, the water conservation board, and the planning board into the Montana public works department.

At the head of the new department would be three men to be selected by the governor with the consent of the Senate, while responsibility for planning the state program in highway building and water conservation would be vested in a director to be appointed by the commission and paid $6,000 a year. The commission members would receive $10 a day while the commission was in session.

Washington Highlights

By Paul Wooton

The Court of Appeals of the District of Columbia on March 8 upheld a lower court's decision refusing to enjoin the federal government from constructing the Thomas Jefferson memorial project in St. Louis. The suit was brought by a group of St. Louis property owners.

A suit brought by the Metropolitan Bridge Company of San Francisco attempting to force the PWA to finance construction of a bridge and vehicle tunnel across San Francisco Bay was dismissed Feb. 19 by the U. S. District Court for the District of Columbia. The court held that the disbursement of PWA funds is entirely within the discretion of Administrator Ickes.

PWA Administrator Ickes has indicated that Congress will be asked to increase the $10,000,000 provided in the 1938 budget for PWA administrative purposes. Mr. Ickes pointed out that although the amount of work the agency will have to do is indefinite, appropriation of only the budgeted amount would mean a 65 per cent cut in PWA personnel and would seriously cripple the efficiency of the administration.

Three bridge bills have been passed by Congress and are now awaiting the President's approval: a bill extending the time for completion of a bridge across the Columbia River near The Dales, Ore., to March 4, 1940; a bill consenting to the construction and operation of a free bridge over the Coosa river near Gilberts Ferry by the state of Alabama or Etowah county; a bill extending the time for beginning and completing a bridge over the Savannah river near Lincolnton, Ga., to Feb. 24, 1938 and 1940, respectively.

BONNET CARRE SPILLWAY IN ACTION

FOR THE FIRST TIME since it was completed several years ago, the Bonnet Carre controlled spillway on the east bank of the Mississippi River, 23 miles above New Orleans, went into action during the recent flood. The spillway consists of a concrete weir 7,000 ft. long, surmounted by 350 bays between piers that are normally kept closed by timber needles. Water passing over the spillway flows into Lake Pontchartrain, six miles away, between two earth guide levees, thereby reducing the flood crest at the city. This view of the spillway was taken when a flow of 200,000 sec.-ft. was passing through the openings. It shows a few of the 59 bays that were purposely kept closed.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, Ill., March 16–18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, San Antonio, Texas, April 21–24.

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D.C., Apr. 26-27.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, mid-winter convention, Albany, N. Y., March 6.

NEW JERSEY SEWAGE WORKS ASSOCIATION, annual meeting, Trenton, N. J., March 11-12.

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION, annual meeting, Atlantic City, N. J., March 17–19.

FLORIDA ENGINEERING SOCIETY, annual meeting, Tampa, Fla., March 18–20.

AMERICAN WATER WORKS ASSOCIATION, INDIANA SECTION, Indianapolis, Ind., March 25–26.

AMERICAN WATER WORKS ASSOCIATION, FLORIDA SECTION, Ocala, Fla., March 30–April 1.

AMERICAN WATER WORKS ASSOCIATION, KENTUCKY-TENNESSEE SECTION, and SOUTHEASTERN SECTION, joint meeting, Chattanooga, Tenn., April 5–7.

GREATER NEW YORK SAFETY COUNCIL, annual convention, New York City, April 13–15.

AMERICAN WATER WORKS ASSOCIATION, CANADIAN SECTION, Montreal, Canada, April 14–16.

AMERICAN WATER WORKS ASSOCIATION, MONTANA SECTION, Lewiston, Mont., April 19–23.

AMERICAN WATER WORKS ASSOCIATION, FOUR STATES SECTION and PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION, joint meeting, Philadelphia, Pa., April 22–23.

AMERICAN WATER WORKS ASSOCIATION, ILLINOIS SECTION, Springfield, Ill., April 29–30.

NORTH CAROLINA INDUSTRIAL SAFETY CONFERENCE, Winston-Salem, N. C., May 20–21.

AMERICAN WATER WORKS ASSOCIATION, PACIFIC NORTHWEST SECTION, Victoria, B. C., May 20–22.

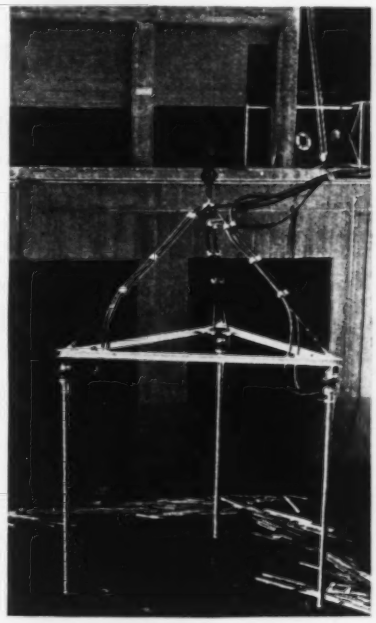
LICENSE EXAMINATIONS

IOWA, examinations for professional engineering on March 18–19 and examination for land surveying on March 20, Des Moines, Iowa.

The following officers were elected by the NEW YORK CHAPTER of the FEDERATION OF ARCHITECTS, ENGINEERS, CHEMISTS AND TECHNICIANS at its Feb. 25 meeting: president, James A. Gaynor; vice-president, Harold Fink; general secretary, Michael Powsner; treasurer, H. A. Steingart; financial secretary, C. Leet; general organizer, Marcel Scherer; national councilman, Alfred Baum.

The MISSISSIPPI HIGHWAY CONTRACTORS ASSOCIATION was organized at a meeting held last February, composed of roadbuilding contractors qualified to bid on state projects. M. G. Cobb was elected president; B. Zeigler, vice-president, Ellis A. Hoffpaiur, secretary-treasurer. The association is a reorganization of the old MISSISSIPPI ROAD BUILDERS ASSOCIATION which has been inactive for several years.

The MARYLAND ASSOCIATION OF ENGINEERS, at its annual meeting in Baltimore, January 28, elected the following officers: President, Nathan L. Smith; first vice president, Bernard L. Crozier; second vice president, Leander Schaidt; secretary, Leroy Kern; treasurer, P. Y. K. Howat; field secretaries, H. W. Parker, and R. R. Glenn; directors, S. S. Steinberg, F. K. Duncan, Perry Nicklin, I. C. Root.



SHOCKING THE FISH

THIS water rheostat in use at Boulder Dam in connection with testing of the 115,000 hp. generators now being put into operation there by the Bureau of Reclamation is, in effect, the largest electric water heater ever devised.

The purpose of the rheostat is to absorb the current generated at a potential of 18,600 volts during test of the generators while operation is being observed under varying conditions of hydrostatic head and pressure. The rheostat consists of three poles to conduct the current of the three-phase cycle into the water of the power house tailrace which furnishes the resistance required to absorb it. Since the resistance is proportional to the depth to which the poles are submerged, behavior of the generating unit may be determined. In order to accomplish this result with precision, a chemical analysis of the water is made to determine its conductive properties and the resistance it would afford.

Fish swimming into the field of the rheostat apparently are electrocuted and float to the surface, but once the current is turned off or they float out of the charged field, they regain life and come away quite unaffected by the experience.

Personals

J. C. LONG, formerly a resident engineer for the Alabama Highway Department, has joined the Alabama WPA staff.

JOE M. MORRISEY, resident state highway engineer for Madison and Union Counties, Ohio, has been appointed to the office of assistant division engineer of construction for six state highway districts.

BEN TORPEN, who was engineer for the federal government on the Bonneville Dam project, has been retained by the City of Seattle, Wash., as consulting engineer on the city's new $8,000,000 Ruby Creek power dam.

F. R. WHITE, chief engineer of the Iowa state highway commission, has been appointed a representative of the United States on the Permanent International Commission of the International Association of Road Congresses.

SPENCER BALL has been appointed head of the department of civil engineering at Nova Scotia Technical College. Professor Ball is a graduate of Acadia University and was formerly dean of the college of engineering at Sao Paulo.

MAJ. THARON D. WEAVER, U. S. Engineer Corps, has been appointed district engineer for the Washington area. Maj. Weaver joined the Engineer Corps during the war and was promoted to the rank of captain in 1919 and to that of major in 1935.

H. T. MCCRADY, HENRY K. MARTIN, WILLIAM BELNAP, HENRY LEAR, and FRANK SCHNORRENBERG, assistant resident engineers, and CHAUNCEY DODGE, instrument man, have been appointed resident county engineers for the Ohio state highway department.

FRANK GERIG, district engineer for the Arkansas State Highway Department, has been appointed maintenance engineer. The following new district engineers have been appointed: W. H. CUSHMAN, M. F. HILL, C. O. THOMAS, FRANK P. KIRK, W. H. STANTON, M. C. METHVIN, and CONE MURPHY.

E. W. LANE, since 1935 professor of hydraulics at the University of Iowa, has taken over direction of the Institute of Hydraulic Research at the University with the title of associate director in charge of laboratory. F. T. MAVIS who has been associate director of the Institute of Hydraulic Research at the University and acting head of the department of mechanics and hydraulics, has relinquished his laboratory duties to be head of the department of mechanics and hydraulics. These changes were announced recently by Dean F. M. Dawson.

Obituary

CLAUDE T. WOOLF, civil engineer of Tacoma, Wash., died there Feb. 19, at the age of 38.

RICHARD DEMING, 73, construction engineer and 1st vice-president, American Surety Company, died at Los Angeles on March 4.

CHARLES H. BARTLETT, who practiced civil engineering and law in Boston for 17 years, before his retirement three years ago, and who supervised the reconstruction of the frigate Constitution, died at Milford, N. H. Feb. 28, at the age of 74. He was a graduate of M.I.T.

FRED E. DEAN, formerly a contractor in Huntington, W. Va., died in Youngstown, Ohio, Feb. 21 at the age of 77. Between 1905 and 1929, Mr. Dean's concern had engaged in paving, bridge construction, and general construction work throughout West Virginia.

HAROLD F. LANE, 52, in charge since

1918 of the Washington office of *Railway Age*, died in Washington Feb. 26. Mr. Lane had been connected with the staff of *Railway Age* since 1911 and before that was railway editor of the Chicago *Tribune*.

EDWARD O. REEDER, retired chief engineer of the Chicago, Milwaukee, St. Paul, & Pacific Railroad died Feb. 21, at Seattle, Wash., at the age of 85. Mr. Reeder was location engineer for the section of line from Mowbridge, S. D. to the Pacific Coast and had supervised construction of the Snoqualmie Tunnel through the Cascade Mountains and the ocean dock and terminals at Tacoma, Wash.

FRANK MESSER, president of Frank Messer & Sons, Inc., Cincinnati general contractors, died in that city February 24, at the age of 58. In 1909, Mr. Messer became associated with the Ohio Building & Construction Company of Cincinnati, later becoming president of the firm. He was also associated with the Midland Construction Company. Founding the firm which bore his name in 1932, Mr. Messer constructed many large buildings in Cincinnati and elsewhere.

ARCHIBALD S. DOWNEY, civil engineer and a partner in the Seattle, Wash., construction firm of A. W. Quist & Company, died in Seattle, Feb. 26 at the age of 63. A graduate in 1896 from Cornell University, Mr. Downey, after service in the Spanish-American War and brief employment with the City of Seattle and the Seattle-Tacoma Interurban R.R. Co., began in 1903 to practice engineering in Seattle and the Pacific Northwest. In 1908 he organized the contracting firm of A. W. Quist Co.

GEORGE C. WALKER, president of the P. J. Walker Co., Pacific Coast construction firm, died Feb. 28 at Los Angeles, Calif., aged 58 years. Mr. Walker was the younger brother of P. J. Walker, founder of the construction firm, who died four years ago. The P. J. Walker Co. erected many notable buildings on the Coast, including the subway terminal, the Los Angeles Stock Exchange, the Richfield, Southern California Edison, Southern California Telephone, Los Angeles Gas & Electric and the Federal Reserve Bank buildings in Los Angeles and the 29-story Shell Oil Building in San Francisco.

WILLIAM M. BEAMAN, chief of inspection and editing of the Topographic Branch of the U. S. Geological Survey, died in Washington at the age of 69. Mr. Beaman was the inventor of the Beaman arc, used on telescopic alidades and was author of the chapter on topographic mapping in the book "Topographic Instructions" issued by the U.S.G.S. He entered the Geological Survey immediately after his graduation in 1889 from Massachusetts Institute of Technology, rising from the rank of topographic aid to his late position which he attained in 1922. During the war he served with the U. S. Engineers with the rank of Major, reporting to the U.S.G.S. as inspector of topography for surveys made for the War Department.

LARGER AWARDS FOR THE WEEK

Syrup manufacturing plant, Coca-Cola Company, Kearny, N. J.	$8[illegible]
Oil refinery, Shell Petroleum Company, Houston, Tex.	$5[illegible]
Blast furnaces, Great Lakes Steel Corporation, Ecorse, Mich.	$2,5[illegible]
Improving refinery and increasing capacity of stills, Pure Oil Company, Toledo, O.	$2,0[illegible]
Improving steel mill, Jones and Laughlin Steel Corporation, Aliquippa, Pa.	$7,0[illegible]
Apartment, 231 East 76th Street Corporation, New York, N. Y.	$500,000
County home, infirmary, and commissioner's residence, Board of Supervisors, Suffolk County, Yaphank, N. Y.	$530,000
Post office and court house,, Peoria, Ill.	$830,000
Highways, Arkansas	$567,000
Highways, Ohio	$655,000
Highways, Illinois	$2,222,000
East Bay Yard substructures of railway facilities of San Francisco-Oakland Bay Bridge, Calif.	$681,000
600,000 barrels of cement, Division of Purchases and Contracting, Raleigh, N. C., estimated	$1,200,000

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Mar., 1937	225.25	108.18	Feb., 1937	181	79
Feb., 1937	223.45	107.41	Jan., 1937	2167	73
Mar., 1936	201.20	96.71	Feb., 1936	176	77
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

CONTRACTS

(Thousands of Dollars)

	Weekly Average Mar. 1936	Weekly Average Prev. 4 Weeks	Week Mar. 11 1937
Fed Government	$1,985	$3,955	$2,550
State and Municipal	20,702	14,351	17,097
Total public	$22,687	$18,306	$19,647
Total private	14,237	26,662	21,441
Week's total	**$36,924**	**$44,968**	**$41,088**

Cumulative to date:
1936 (11 weeks) $335,526,000
1937 (10 weeks) $435,487,000

Note: *Engineering News-Record* reports waterworks and earthwork, reclamation or waterways projects of $15,000 and over in size; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000 and over. The figures above represent the volume of contracts and large force account projects throughout the U. S. that are of these minimum sizes or over.

NEW PRODUCTIVE CAPITAL

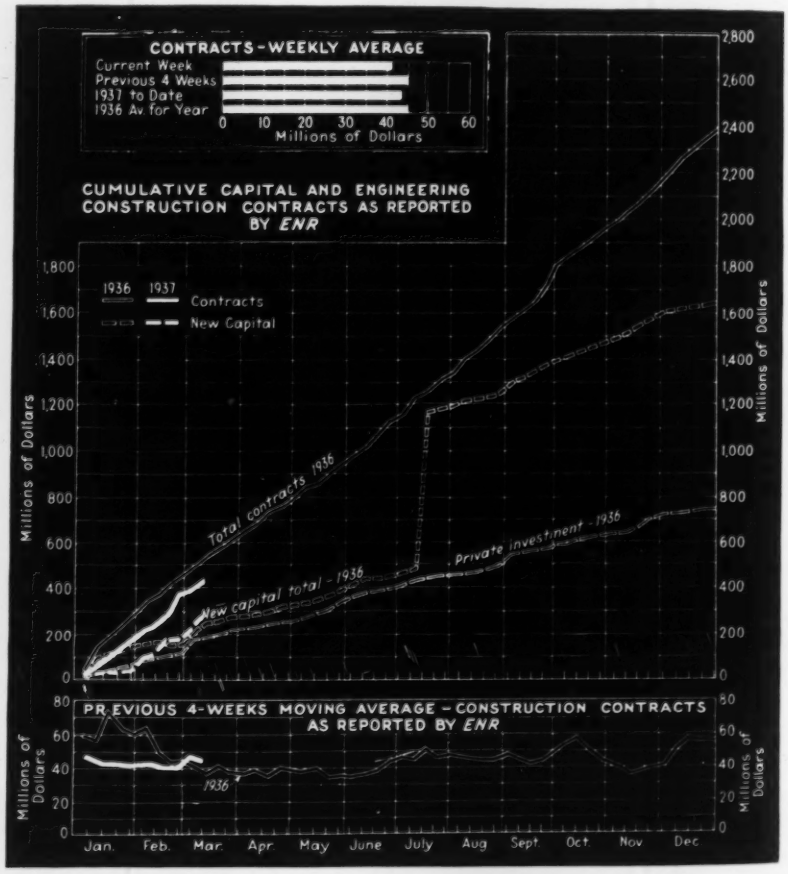
(Thousands of Dollars)

1937	Week Mar. 11	Cumulative
Private investment	**$53,941**	**$247,893**
State and municipal bonds	3,058	129,907
Corporate securities	50,283	117,986
Federal financing	**$301**	**$41,176†**
PWA non-federal Projects	301	$41,176†
Total non-federal	**$54,242**	**$289,069**
Federal projects		
Total	**$54,242**	**$289,069**

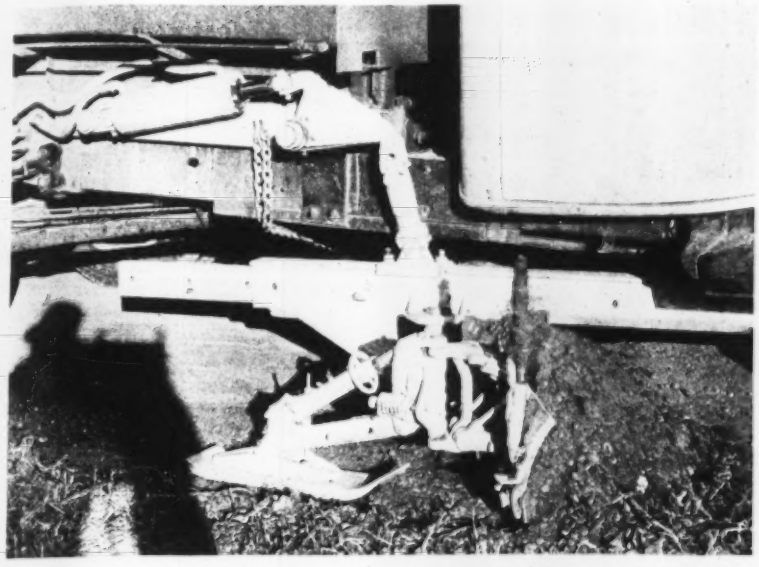
Cumulative to date:
1936 (11 weeks) $274,716,000
1937 (10 weeks) $289,069,000

Note: These figures include private bonds and stocks sold for new construction purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

† Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.



Construction Equipment and Materials



TRUCK PATROL made by St. Paul Hydraulic Hoist Co.

Three Road Maintenance Units

The St. Paul Hydraulic Hoist Company, of Minneapolis, Minn. has developed three new road maintenance units to be attached to trucks—a truck patrol, a scarifier and a patch roller. All three are so designed that they will draw up under the chassis of the truck leaving plenty of road clearance.

Outstanding feature of the truck patrol is a new patented levelizer. With this device a balance is maintained between the downward pressure from a hydraulic ram and an upward hydraulic pressure controlled by a skid placed behind the blade. This is said to keep the blade on an even plane at all times, thus giving a smoother road and at the same time leaving full traction on the truck wheels.

The scarifier may be substituted readily for the blade of the truck patrol, or may be installed independently in a truck.

The patch roller is a three-roller unit, hydraulically controlled, which is said by its kneading action to give a thoroughly compacted patch.

All three units are hydraulically controlled for one-man operation from the cab.

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Long Range Floodlight

A floodlight which can be used on construction work mounted at distances up to 275 ft. from the area to be lighted has been developed by the Benjamin Electric Manufacturing Company, Des Plaines, Ill.

The floodlight has a special projector-shape reflector of Alzak aluminum. The section behind the lamp is polished to produce a concentrated beam at high candlepower to carry over considerable distances, while the section in front of the lamp is etched to give a certain degree of spread to the light. A deflector located above the lamp is made of etched Alzak aluminum.

Four styles of removable hood-bracket assemblies are available; cross arm, for attachment to a wooden cross arm, or flat surface; pipe clamp, for clamping around 1 or 2 in. pipe; and pole cap, to slip over the end of 1½ or 2 in. pipe.

Lamps from 750 to 1600 watts can be accommodated.

Improved Insulating Sheathing

The Celotex Corp., Chicago, have developed certain improvements on their Celotex ½ in. sheathing, which now in its improved form is called Celotex Vaporseal Insulating Sheathing. Looking particularly towards meeting the needs of air conditioned buildings, the improvements have been directed toward increased insulating efficiency and protection of the sheathing against moisture. A special moisture-resi-tant asphalt coating has been applied on both sides and all edges of the sheathing. In addition, one side is treated with a bright reflecting aluminum compound intended to give vapor protection. As another change, Vaporseal Sheathing is marked along the stud placements to indicate where nails should be driven.

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Two New Graders Added To Caterpillar Line

Two new blade graders, in 12-ft. and 10-ft. sizes, have been added to the Caterpillar grader line. These new models, which have single member frames, are designated No. 66 Single Frame and No. 44 Single Frame to distinguish them from the double frame models in the same weight classes. The new models are offered with both power and hand control.

These new machines, the manufacturer states, are designed particularly for combination work in which quick movement of the blade from ditching position to the high range cutting position is important. With the power controlled model, less than one minute is required to move the blade from one of these positions to the other, and with any of the models this may be done without off-setting the blade on the blade arms or making any change in lifting or lateral shift links.

Both blade lift links, it is stated, are of the telescopic type and may be quickly extended for securing the most extreme blade position for unusual jobs.

Current Construction Unit Prices

Dam 13, Mississippi River

A DAM, 5139 ft. long, will be built across the Mississippi River 4.5 miles above Clinton, Iowa, to be known as Dam No. 13 of the 9-ft. canalization program. The dam will include a movable section 1,066 ft. long formed of ten tainter gates, each 64x20-ft. and three 100x20-ft. roller gates, a 200-ft. storage yard, 1,650 ft. of submersible earth dike and 2,223 ft. of non-submersible earth dam. After being notified to proceed with the work, the contractor must complete the work in 730 calendar days. Minimum hourly wages vary from $1.25 for bricklayers and boiler makers to 50c for common labor. Nine bids for the work were opened Jan. 5, 1937 at the Rock Island District Office of U. S. Army Engineers, and the low bidder was (A) McCarthy Improvement Co., Davenport, Iowa, (contract) $2,384,289; (B) Maxon Const. Co., Dayton, Ohio, $2,491,310; (C) S. A. Healy Co., Chicago, Ill., $2,496,944. The government estimate was $2,442,122. Unit prices of the three lowest bidders follow:

DAM No. 13, MISSISSIPPI RIVER

	A	B	C
1. Cofferdam—1,114 lin.ft.	$310.00	$300.00	$220.00
2. Clearing—job	5,000	5,000	6,266
3. Common excavation—60,000 cu.yd.	0.30	0.40	0.35
4. Dredged excavation—250,000 cu.yd.	0.22	0.20	0.20
5. Top soil excavation—25,000 cu.yd.	0.50	0.50	0.20
6. Common fill—9,000 cu.yd.	0.50	0.50	0.17
7. Dike embankment—200,000 cu.yd.	0.25	0.20	0.24
8. Round timber piling, vertical—156,000 lin.ft.	0.70	0.70	0.765
9. Concrete piling—2,610 lin.ft.	2.45	3.00	3.25
10. Steel sheet piling (type A)—54,800 sq.ft.	1.20	1.50	1.20
11. Steel sheet piling (type B)—15,250 sq.ft.	1.25	1.55	1.40
12. Steel sheet piling (type C)—28,800 sq. ft.	0.50	0.80	0.95
13. Steel sheet piling (type D)—44,000 sq.ft.	0.52	0.85	0.95
14. Pile loading test—5, each	600.00	700.00	475.00
15. White oak timber—3 M.F.B.M.	310.00	300.00	410.00
16. Soft wood timber (plain and creo.)—42 M.F.B.M.	140.00	225.00	160.00
17. Derrick Stone—13,000 cu.yd.	4.00	5.00	4.50
18. One and two man stone—13,000 cu.yd.	3.00	2.50	4.00
19. Riprap—10,000 cu.yd.	3.00	2.50	4.00
20. Crushed or gravel stone—10,000 cu.yd.	2.50	2.00	2.50
21. Stored stone—5,000 cu.yd.	2.30	2.00	3.80
22. Rehandled stone—5,000 cu.yd.	0.75	1.50	1.00
23. Road gravel—1,500 cu.yd.	2.00	4.00	5.20
24. Concrete slushing—950 cu.yd.	8.00	15.00	13.00
25. Class "A" concrete—750 cu.yd.	25.00	20.00	40.00
26. Class "B" concrete—37,250 cu.yd.	12.40	12.90	14.00
27. Steel, service bridge—1,627,500 lb.	0.08	0.078	0.078
28. Steel, Tainter gate—1,860,000 lb.	0.087	0.09	0.09
29. Steel, roller gate—940,000 lb.	0.115	0.119	0.119
30. Steel, miscellaneous—733,000 lb.	0.081	0.10	0.10
31. Steel, manganese—263,000 lb.	0.095	0.092	0.092
32. Steel, chromium—92,000 lb.	0.12	0.10	0.10
33. Reinforcing steel—1,225,000 lb.	0.035	0.05	0.0438
34. Corrosion resisting steel—18,500 lb.	0.67	0.70	0.70
35. Steel forgings—267,000 lb.	0.123	0.15	0.16
36. Nickel steel forgings—2,450 lb.	0.56	0.50	0.48
37. Chromium steel forgings—13,500 lb.	0.24	0.20	0.185
38. Steel castings—257,000 lb.	0.152	0.20	0.19
39. Alloy steel castings—31,000 lb.	0.185	0.30	0.30
40. Iron castings—1,350 lb.	0.15	0.10	0.10
41. Bronze—7,175 lb.	0.73	0.50	0.48
42. Copper—280 lb.	0.30	0.60	0.58
43. Lead—650 lb.	0.29	0.20	0.17
44. Wrought iron pipe, black std. 6 in.—420 lin.ft.	4.00	6.00	3.70
45. Wrought iron pipe, black std. 3 in.—350 lin.ft.	1.75	2.50	1.72
46. Wrought iron pipe, black std. ¾ in.—233 lin.ft.	1.00	1.75	0.25
47. Copper tubing, 1 in.—850 lin.ft.	1.00	1.00	1.10
48. Fiber conduit, 4 in.—95 lin.ft.	1.00	1.00	0.90
49. Fiber conduit, 3 in.—800 lin.ft.	0.80	0.75	0.85
50. Rigid metal conduit, 3 in.—110 lin.ft.	1.40	1.00	0.90
51. Rigid metal conduit, 2 in.—10 lin.ft.	1.35	0.90	0.75
52. Rigid metal conduit, 1½ in.—625 lin.ft.	0.90	0.80	0.42
53. Rigid metal conduit, 1¼ in.—40 lin.ft.	0.80	0.75	0.40
54. Rigid metal conduit, 1 in.—125 lin.ft.	0.75	0.70	0.60
55. Rigid metal conduit, ¾ in.—205 lin.ft.	0.70	0.70	0.60
56. Electrical grounding system—job	400.00	300.00	280.00
57. Crane track, 80-lb. rail—1,383 trk.ft.	4.25	3.50	3.35
58. Steel pipe railing—1,445 lin.ft.	2.25	2.80	2.80
59. Steel floor gratings—156 sq.ft.	1.42	1.50	1.50
60. Moulded rubber seals—6,450 lb.	1.00	1.10	1.60
61. Operating machinery—3, each	27,500	26,000	28,000
62. Roller gate mach., spare parts—1, lot	1,000	700	650
63. Roller gate operating house—4, each	4,500	6,000	5,525
64. Tainter gate operating mach.—10, each	18,220	17,500	18,300
65. Tainter gate spare parts—1, lot	300.00	250.00	240.00
66. Tainter gate mach., spare parts—1, lot	500.00	200.00	165.00
67. Tainter gate heaters—6, each	750.00	515.00	515.00
68. Tainter gate heater spare parts—1, lot	300.00	380.00	380.00
69. Roller gate heaters—3, each	2,750	4,000	4,000
70. Roller gate heater spare parts—1, lot	910.00	1,400	1,350
71. Install. loco. crane on service bridge—job	1,500	2,000	1,680
72. Storage yard trucks—6, each	500.00	500.00	400.00
73. Service bridge trucks—2, each	700.00	550.00	515.00
74. Central control station structure—job	28,300	23,000	25,500
75. Piezometer system—job	900.00	4,700	500.00
76. Moving temporary buildings—job	300.00	1,000	350.00

Yakima Ridge Canal and Siphon

CONSTRUCTION of the Yakima Ridge canal, flume and siphon, located 9 mi. north of Yakima, Wash., is scheduled for 500 days completion after award of contract on basis of bids received in December, 1936. The concrete-lined canal section, extending for 3,600 ft. has a bottom width of 14 ft. with 1¼:1 sloped sides giving a center depth of 11.2 ft. The concrete bench flume section is 4,468 ft. long with a cross sectional dimension of 28x13 ft. Some 1,500 ft. of monolithic concrete siphon dimension follow averaging 15,33 ft. in diameter and from 14 to 22 in. in thickness.

Minimum hourly wage rates are stipulated of $1.20 for skilled and 50¢ for common labor, with the government furnishing, f.o.b. Pomona, all cement, aggregates, reinforcing and structural steel and fittings, and all other materials generally entering into the completed work with the exception of backfill material, gravel and rock for dry rock and grouted paving.

The following tabulation lists the units and totals for the three low bidders on each section of the work which is under the jurisdiction of the U. S. Bureau of Reclamation Engineers. Section I: Canal and flume—(A) J. A. Terteling & Sons, Boise, Idaho, $196,391; (B) Gunther & Shirley Co. and J. P. Shirley, Los Angeles, Calif., $225,237; (C) Morrison-Knudsen Co., Inc., Boise, Idaho, $225,827. Section II: Pomona Siphon—(D) Guy F. Atkinson Co., Mason City, Wash., $165,458; (E) J. A. Terteling & Sons, Boise, Idaho, $178,019; (F) Morrison-Knudsen Co., Inc. Boise Idaho, $194,483.

YAKIMA RIDGE CANAL AND SIPHON

I — Earthwork, flume, canal, structures	A	B	C
1. Earth excavation — 180,000 cu. yd.	$0.23	$0.20	$0.275
2. Rock excavation — 90,000 cu. yd.	.23	.70	.275
3. Overhaul — 5,000 sta. cu. yd.	.05	.02	.06
4. Earth excav. struct.— 150 cu. yd.	1.00	1.00	.85
5. Rock excav. struct.— 50 cu. yd.	1.00	2.00	2.00
6. Earth excav. channels — 270 cu. yd.	.25	1.00	.20
7. Rock excav. channels — 50 cu. yd.	1.00	2.00	1.50
8. Compact embankment — 5,200 cu. yd.	.25	.40	.35
9. Prepare rock fdt., flume — 8,000 sq. yd.	.60	.40	.50
10. Trim earth fdt., flume — 30,000 sq. yd.	.30	.25	.45
11. Backfill, struct.— 9,000 cu. yd.	.20	.20	.30
12. Puddle, tamp backfill — 350 cu. yd.	.30	.50	.60
13. Structure concrete — 80 cu. yd.	15.00	20.00	18.00
14. Flume bench concrete — 8,350 cu. yd.	8.00	8.00	9.00
15. Canal lining concrete — 2,480 cu. yd.	8.00	6.00	8.50
16. Place reinforcing bars — 1,530,000 lb.	.015	.015	.016
17. Dry rock paving — 25 sq. yd.	1.00	2.00	2.00
18. Grouted paving — 70 sq. yd.	3.00	2.00	4.00
19. Erect bridge steel — 7,600 lb.	.03	.015	.05
20. Erect bridge timber — 4 M.B.M.	20.00	40.00	60.00
21. Underdrain, unemt'd., 6 in. — 7,300 in. ft.	.50	.40	.50
22. Underdrain, unemt'd., 8 in.— 1,550 lin. ft.	.75	.40	.70
23. Lay sewer pipe, 6 in.— 350 lin. ft.	.50	.40	.70
24. Lay sewer pipe, 8 in — 370 lin. ft.	.75	.40	1.00
25. Install misc. metal — 2,400 lb.	.05	.10	.10

II — Siphon and Wasteway	D	E	F
26. Earth excav. struct.— 51,000 cu. yd.	$0.50	$1.00	$0.90
27. Rock excav. struct.— 12,300 cu. yd.	1.50	2.25	1.50
28. Struct. backfill — 41,800 cu. yd.	.20	.25	.22
29. Puddle, tamp backfill — 300 cu. yd.	.60	.50	1.00
30. Concrete, structures — 4,630 cu. yd.	20.00	14.00	20.00
31. Place reinforcing bars — 1,496,000 lb.	.0125	.015	.017
32. Install gates, hoists — 36,200 lb.	.03	.03	.05
33. Install blow-off valve, etc— 5,200 lb.	.06	.05	.10
34. Install pipe handrails — 1,500 lb.	.08	.05	.10
35. Install misc. metal — 1,250 lb.	.12	.05	.10